VOLUME 26 • NUMBER 2

May 1955

the RESEARCH quarterly

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Published in March, May, October, and December by the American Association for Health, Physical Education, and Recreation, 1201 Sixteenth Street, N.W., Washington 6, D. C. Subscription available to libraries, institutions, and departments at $5.00 per year. Of the Professional Membership ($10.00 per year), $3.00 covers subscription to the *Quarterly*. Of the Student Professional Membership ($5.00 per year), $1.50 is for subscription to the *Quarterly*. *Subscriptions to individuals through membership only.* Single copies $1.25.

Send membership dues or subscriptions to Circulation Dept., 1201 Sixteenth Street, N.W., Washington 6, D. C. Editorial Office, 1201 Sixteenth Street, N.W., Washington 6, D. C. Entered as second-class matter at the Post Office at Washington, D. C., under the act of March 3, 1879. Additional entry at Baltimore, Md.

Forces in Swimming Two Types of Crawl Stroke

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Abstract

In this study the resistive and propulsive forces of three swimmers swimming two types of crawl stroke—the glide stroke and the continuous stroke—were measured. An apparatus was constructed which utilized strain gauges to measure these forces. It was found that the continuous stroke was faster than the glide stroke and created more propulsive force with less fluctuation in the application of the force.

STUDIES OF THE crawl stroke have attempted to analyze the efficiency of various techniques by studying the resultant propulsive force and/or the resistive force. Since the balance of these two forces determines the efficiency and speed with which an object goes through the water, this approach appears to be scientifically sound. A careful examination of the literature in this area will show, however, that little consideration has been given to the evenness of the application of these forces.

The purpose of this study is to examine the evenness of the application of the propulsive forces in two types of crawl stroke—the glide stroke and the continuous stroke.

Since there has been much speculation concerning the effect of the rolling of the body upon the total resistance of the swimmer, as well as the resistance created by the swimmer in various positions, consideration was given to the drag created by the swimmer in various positions and during the time the swimmer was rotating on his longitudinal axis.

The most common method of teaching and coaching the arm action of the crawl stroke in this country has been that of providing a pause in the arm stroke when the arm is extended in front of the body (1, *p. 114* and 5, *p. 9*). This position is held by one arm while the other pulls and recovers. The arm which has been maintaining the gliding position then completes its cycle while the other arm glides. The logical basis for this method is believed to lie in the fact that one arm is resting during the time the other is working. This would seem to enable the swimmer to swim without tiring as quickly as he would when using an immediate or continuous pull without the period of rest. This glide timing may result, however, in a constant fluctuation of velocity, a positive acceleration during the pull and a negative acceleration during the recovery of the arm while there is no propulsive force from the other arm. In this study, this stroke will be referred to as the *glide stroke.*

Some swimming coaches and teachers have attempted to decrease the amount of fluctuation of propulsive force and of velocity by teaching their swimmers to eliminate the glide phase of the arm stroke by beginning the arm pull as soon as the arm enters the water. This type of stroke will be referred to as the *continuous stroke.*

Procedure

The method of analyzing the efficiency of the two strokes so far as speed was concerned presented no serious problem. The *stop watch* method of research was used and the time it took the two types of stroke to cover a given distance was recorded.

The most accurate and efficient method of measuring resistive force or *drag,* according to specialists in hydrodynamics (6, 7), is to tow the object in a towing tank under controlled laboratory conditions. The literature showed no evidence that this had ever been attempted in the area of swimming. However, several attempts using equipment which appeared satisfactory have been reported. Karpovich (4, *p. 21*) reports on several early attempts:

> R. DuBois-Reymond (1905) towed several persons behind a row boat, measuring resistance by a dynamometer. G. Liljestrand and N. Stenström (1919) towed swimmers by means of a windlass on shore, the towing rope running over a pulley which in turn operated a spring scale.

Karpovich designed a resistograph which was similar to the apparatus devised by Liljestrand and Stenström. Karpovich recorded the tension of the spring upon a kymograph (4).

To measure forces involved in swimming, Alley (2, *p. 256*) constructed a platform which was suspended over the water by cables. A motor on the platform towed the swimmer toward the apparatus or released him as he swam away from it. A spring scale was attached to the platform and to the side of the pool to measure the force the swimmer exerted upon the platform. A kymographic record was made of this force.

THE APPARATUS

The towing apparatus (Figure 1), which was similar in many respects to Alley's, consisted of a one-horsepower motor equipped with a series of step pulleys. A "V" belt ran from these pulleys on the motor to a series of step pulleys on a shaft. A linen line 150 feet in length was attached to one end of the shaft and then passed through a belt and attached to the other end of the shaft. During the trials this belt was held in the swimmer's hands when he was being dragged toward the apparatus or was buckled around his waist when he was swimming away from the apparatus. As the shaft turned, the string wound from the distal ends of the shaft toward the center; in this way the cord did not wind over itself.

The speed at which the swimmer was towed or released could be controlled by the arrangement of the belt on the pulleys. The motor and shaft were mounted on a framework of two-inch by four-inch boards which was sus-

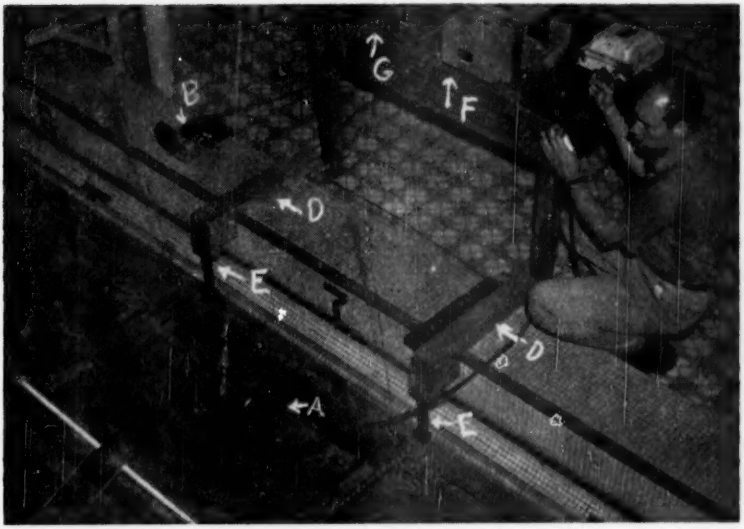

FIGURE I. Towing Apparatus, Measuring Device, and Pacing Device. *Key:* A. Motor; B. Placing device; C. Step pulley; D. Iron clamps; E. Steel beams; F. MRC Strain Gage Control Unit; and G. Hathaway S14-C Galvanometer.

pended over the water by four one-eighth inch flexible steel cables equipped with turnbuckles. Before each series of runs the platform was checked with a machinist's level to see that it was level and indicated adjustments were then made with the turnbuckles.

A series of time trials were made over a 30-foot course to determine whether the various loads which would be placed on the motor would cause a variation in the speed with which the person was towed or released by the motor. These tests were conducted with: 1. the subject being towed towards the apparatus in a drag position and 2. two subjects being towed simultaneously in the same manner as in the first instance, 3. the subject being released while he stroked slowly—a tempo of 1.74 seconds per arm cycle, and 4. the subject being released while he increased his stroke tempo—1.20 seconds per arm cycle.

The mean time for the first type of trial was 9.203 seconds for 30 feet with an average velocity of 3.259 feet per second; for the second was 9.213 with a mean velocity of 3.256 feet per second; for the third was 9.206 with a mean velocity of 3.259 feet per second; and for the fourth the mean time was 9.221 seconds and the mean velocity was 3.253 feet per second. The observed difference between the means of .018 sconds was not significant according to the t test. Norms for the various pulleys had been established by a series of time trials and these were used to determine the velocities.

In Alley's study (2, *p. 257*), the towing device was attached to a spring scale by a cable and the force exerted on the platform by the swimmer was recorded by the scale. Alley (3, *p. 20*) suggested that in future studies a more stationary apparatus be used since the employment of a spring scale permitted too much swinging motion of the apparatus. This not only gave a rough line reading but also permitted the effect of gravity on the platform—as the swimmer pulled it out—to change the readings within the limits of the spring.

To measure the forces exerted upon the platform more accurately and to provide a more stable platform, the spring scale was replaced by two steel beams. These beams were attached to the sides of the pool by iron clamps and one to each corner of the platform nearest the pool by means of adjustable turnbuckles. These beams permitted less than 1/100 inch of movement when placed under loads up to 50 pounds.

Four 500 ohm bobbin type strain gauges were attached to each metal beam. These gauges measured the amount of deflection imparted to the beams by various loads. The strain gauges were connected with a Hathaway MRC-12 strain gauge control unit which served as an amplifier. The recording galvanometer was a Hathaway S14-C and recorded the force exerted on the beam on recording paper which was unwound at the rate of one inch per second.

The measurements from both beams were made one above the other on the same recording paper. A timing wave of 60 cycles per second was recorded in the space between these two lines to determine the time element. The timing wave was also used to mark certain key positions in the stroke. When it was used for this purpose, the timing wave switch was clicked on and off each time the right hand hit the water.

The pacing device, which was identical with that used by Alley (2, *p. 258*), included a horn which could be sounded at predetermined intervals.

To determine the tempos to be used in the study, data were collected from the fastest ten swimmers in each event at the 1951 National AAU Indoor swimming meet at Columbus, Ohio. The average stroke tempo for the 100-yard freestyle event for the fastest ten men was 1.20 seconds, in the 440-yard race it was 1.66 seconds, and in the 1500 meters it was 1.74 seconds. It was decided to use the 100-yard freestyle tempo of 1.20 seconds as one stroke tempo and the 1500-meter freestyle stroke tempo of 1.74 seconds as the other.

SUBJECTS

The subjects were well trained in the execution of both types of crawl stroke studied and each had a good background in competitive swimming. All three had been selected for the collegiate all-American swimming team and all three were in excellent condition during the period of testing.

METHOD OF SECURING DATA

The entire study was made in the State University of Iowa Field House swimming pool. Each swimmer swam away from the apparatus while being

tested using the various strokes and tempos. During the testing for the resistance created at the various speeds and positions, the swimmers were towed toward the apparatus in the drag positions.

Subject 1 was tested in four drag positions to determine the effect of rolling upon his total drag resistance. He was towed while in the prone position, while on his side, while rolling consciously, and while being rolled by an external force.

The subjects became well acquainted with the apparatus and the procedure before any trials were made. Three satisfactory trials were made at each speed, tempo, and stroke for each subject. In each trial, the subject had reached a stage of zero acceleration before the record of stress exerted on the towing apparatus was utilized. If the swimmer began using an incorrect technique or lost rhythm with the pacing device, the trial was considered void.

The arrangement of pulleys permitted the use of twelve possible speeds. It was finally decided to use the following: 0 feet per second, 1.03 feet per second, 1.95 feet per second, 2.61 feet per second, 3.17 feet per second, 4.11 feet per second, 5.17 feet per second, 5.55 feet per second, 6.55 feet per second, and 7.03 feet per second. The surplus propulsive force was tested only at the speeds less than that of the free swimming speed for that stroke and tempo.

As a result of a suggestion by Alley (3, *p. 29*), the feet were supported by balsa wood floats when the swimmer was dragged at the slower speeds of 1.03 feet per second, 1.95 feet per second, and 2.61 feet per second.

The galvanometer and recording device were electrically balanced before each series of runs.

Definition of Terms

While many of the terms used in this study are commonly understood, there are others which are peculiar to studies of this type and therefore need clarification.

Drag Position. When the swimmer is neither stroking nor kicking and is being dragged toward the apparatus, he is in the drag position. Drag force or resistance refers to the force he creates while in this position.

Surplus-Propulsive Force. The surplus-propulsive force is that force over and above that which the swimmer requires to pull himself through the water. When he is being restrained, he exerts this force on the restraining device.

Effective-Propulsive Force. The effective-propulsive force is defined by Alley (2, *p. 255*) as "the surplus-propulsive force for any given velocity plus the *drag* for that same velocity. It is thus a *computed* measure of the total propulsive force a swimmer can exert at any given velocity."

Fluctuation of Propulsive Force. In this study the fluctuation of propulsive force will refer to the fluctuation between the average of the highest points or maximum amount of effective propulsive force and the average of the lowest points or minimum amount of effective propulsive force.

Analysis of Data

DRAG IN THE PRONE POSITION

The results of the drag measurements in the prone position for all three subjects may be found in Figure II. Pounds of resistance or drag are plotted against velocity in feet per second. The drag of Alley's subject (3, *p. 79-81*) is also plotted on this graph. The line drawn in each case for all of the subjects is an arithmetical average of three trials.

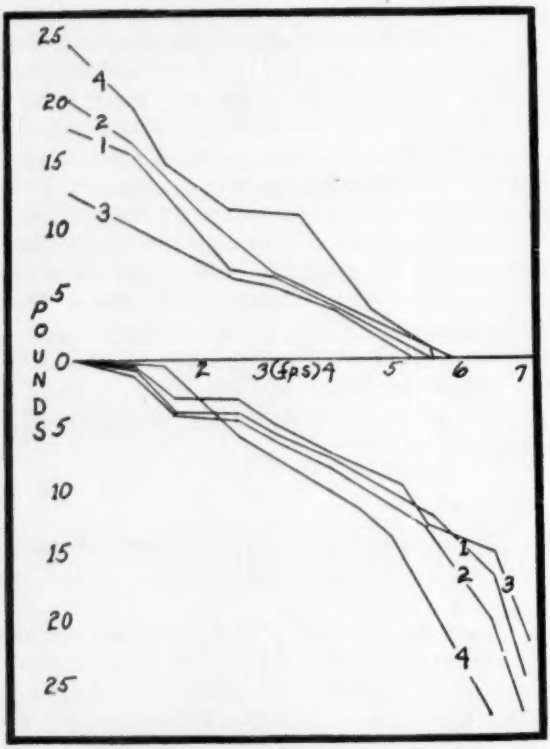

FIGURE II. Surplus-Propulsive Force of the Continuous Stroke with Fast Tempo and Drag in the Prone Position for Four Subjects. *Key:* Data above the middle line represent surplus-propulsive force; data below the middle line represent drag in the prone position. 1—Subject 1; 2—Subject 2; 3—Subject 3; 4—Alley's subject.

The drag measurements at the slow speeds taken from the subject in Alley's study were less than that of all of the three subjects in this study. Between the velocity of 1.4 feet per second and 2.6 feet per second it becomes greater than that of all of the other three subjects and stays significantly so throughout the

remaining speeds. This discrepancy in resistance seems to be outside the range one would normally expect. It is probably due not only to a difference in drag from subject to subject but also to the method of testing the drag. The effect of gravity upon the platform in Alley's experiment may account for this discrepancy and also for that in surplus-propulsive force which is almost of the same magnitude. This deviation is greatest when the surplus-propulsive force or drag is greatest.

The leveling off of the drag line between 1.95 feet per second and 2.6 feet per second was attributed to the fact that between these speeds the feet rose to a higher position and thus reduced the effective area in contact with the flow. This change is not evidenced in the plot of Alley's subject. The sharp increase in drag resistance that is evident between the speeds of 6.55 feet per second and 7.03 feet per second can be attributed, at least partially, to the formation of a bow wave which produced an increase in the area exposed to the flow as well as an accompanying change in the geometry of the flow pattern. The bow wave became perceptible at the speed of 5.17 feet per second. The greatest increase in size of the bow wave seemed to occur between the speeds of 6.55 feet per second and 7.03 feet per second.

DRAG IN DIFFERENT POSITIONS

The results of the drag measurements for Subject 1 in the four positions are shown in Figure III. This subject created the least resistance at every

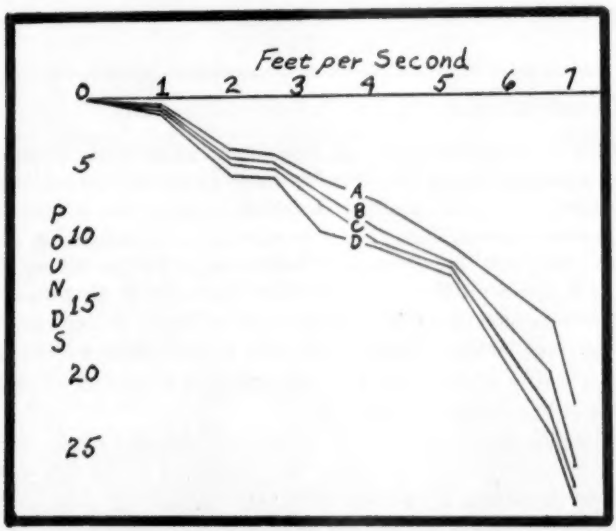

FIGURE III. Drag for Subject 1 in the Four Drag Postions. *Key:* A—Prone position; B—Side position; C—Being rolled; D—Rolling.

velocity when he was dragged in the prone position. When he was dragged on his side, he created more resistance than when he rolled or was being rolled only at the first speed of 1.03 feet per second. The subject created the most resistance when he was rolling consciously. This method probably created more resistance than when he was rolled by an external force because the subject had to use his legs as rudders to cause him to roll.

The subject created less resistance in the prone position than in the side position because the flow of water against his feet tended to lift them and to streamline the body to a greater extent. The water flow when the swimmer was being dragged on his side did not elevate his feet as much and, consequently, the body was not as streamlined and more of the body was submerged.

The general increase in the drag readings, while the subject was rolling or being rolled, over the readings while he was being dragged in the prone or side position was probably due to the fact that the body was less streamlined when rolling. It is also likely that, as the subject rolled, the addition of a rotary motion increased the velocity of body segments locally, and, consequently, increased the drag.

As has been previously mentioned, some writers have theorized that the existence of a roll while swimming might cause the swimmer to delay the beginning of the creation of the bow wave to a higher speed than when the swimmer was in a prone position. In all of the positions, the bow wave appeared to be of the same magnitude at any given speed. The magnitude of the bow wave was determined merely by observation and not by any objective method.

EFFECTIVE-PROPULSIVE FORCE

The effective-propulsive force of Subject 1, using both strokes at both tempos, is shown in Figure IV. This force was determined by adding the drag of the swimmer in a prone position at a given speed to the surplus-propulsive force at the same speed. Since a swimmer rolls when swimming and at any given speed will create more resistance when dragged while rolling than when dragged in a prone position, it would have been preferred to use the drag measurements taken while the swimmer was rolling or being rolled. Unfortunately, however, sufficient data for all three subjects were not available.

Since the graphs of the other two subjects were so similar to that of Subject 1, they have not been reproduced.

The noticeable drop in the amount of effective-propulsive force between the speeds of 1.95 and 2.61 feet per second was explained by the fact that between these speeds there was a leveling off in the amount of drag and no corresponding leveling off in the amount of surplus-propulsive force. It appeared that considerably more propulsion was required at the higher speed to overcome almost the same resistance as was encountered at the lower speed.

Since this did not seem probable, this drop in propulsion was accounted for by the fact that, when being released at the velocity of 1.95 feet per second, the speed of the swimmer's pulling arm, relative to the water, was greater than it was at the speed of 2.61 feet per second. Since the thrust of the arm is a function of the speed of the arm relative to the water, the arm pull created more surplus-propulsive force at the slower speed. The general drop in the three top lines as the velocity increased might also be accounted for in this manner.

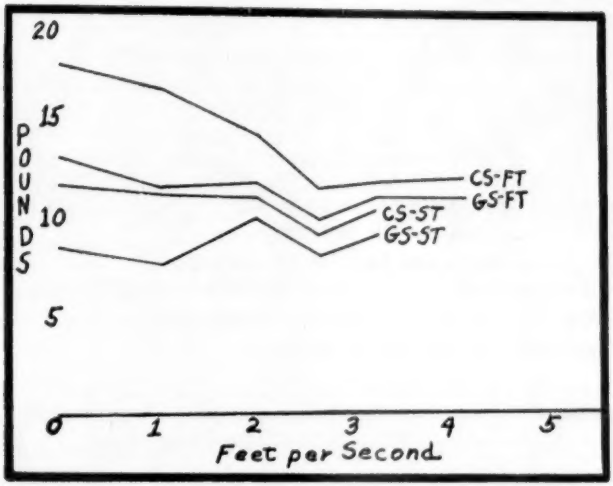

FIGURE IV. Effective-Propulsive Force of Subject 1 for Both Strokes and Tempos. *Key:* CS–FT—Continuous stroke with fast tempo; GS–FT—Glide stroke with fast tempo; CS–ST—Continuous stroke with slow tempo; GS–ST—Glide stroke with slow tempo.

The strokes and tempos as used by all three subjects created effective-propulsive force in the same order as shown in Figure IV. From greatest to least they were: continuous stroke, fast tempo; glide stroke, fast tempo; continuous stroke, slow tempo; glide stroke, slow tempo. This was also the order in which the strokes were ranked on the basis of the free swimming speed they could create. The free swimming speed was determined by timing the subjects for a ten-yard swim using the various strokes and tempos. The stop watch was started when the subject's head crossed a line and it was stopped when the subject's head crossed a second line ten yards from the first line. The subject was permitted to swim ten yards before crossing the first line so he would have achieved maximum acceleration before the timing began.

The average free swimming velocities of ten time trials for each stroke, tempo, and subject in feet per second are presented below:

	Subject 1	Subject 2	Subject 3
Cont. Stroke, Fast Tempo	5.62	5.80	5.19
Glide Stroke, Fast Tempo	5.41	5.43	4.81
Cont. Stroke, Slow Tempo	4.21	4.46	4.30
Glide Stroke, Slow Tempo	4.08	4.30	4.15

FLUCTUATION OF FORCE

To make an accurate comparison of the fluctuation in force between the two strokes, the amount of fluctuation was compared with the total effective force. In Figure V, the percentage that the pounds of fluctuation are of the pounds of effective-propulsive force for the subject (Subject 1), the various strokes, and tempos is plotted against the velocity in feet per second.

In nearly every case it was apparent that with a given stroke and velocity, the slow tempo in general created more fluctuation in proportion to the effective-propulsive force than did the fast tempo.

Figure V shows clearly the fact that for any tempo or velocity, the continuous stroke created less fluctuation in proportion to the effective-propulsive force than did the glide stroke. Figure V also demonstrates that as the velocity increased the amount of fluctuation decreased.

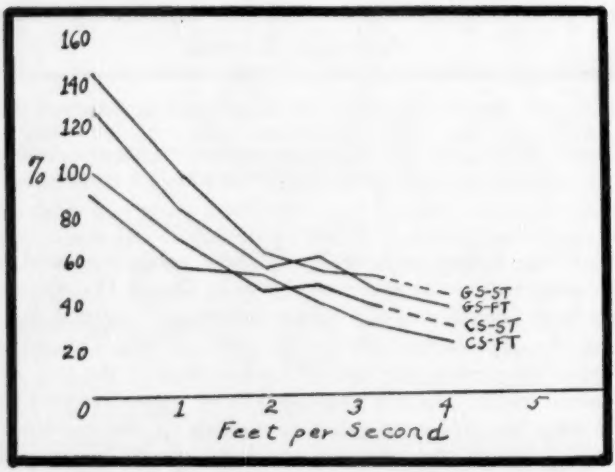

FIGURE V. The Amount of Fluctuation as Percentage of Effective-Propulsive Force of Subject 1 for Both Strokes and Tempos. *Key:* GS–ST—Glide stroke with slow tempo; GS–FT—Glide stroke with fast tempo; CS–ST—Continuous stroke with slow tempo; CS–FT—Continuous stroke with fast tempo.

This decline in the amount of fluctuation probably resulted from the greater forward inertia possessed by the swimmer. A relatively small force, such as that of the kick, when combined with this inertia might still contribute some propulsive force to the swimmer, no matter if this force, when applied without the inertia could create a velocity less than that developed by the inertia.

The effect of the recoil of the string at the slower speeds was no doubt greater than it was at the faster speeds so that part of the difference in fluctuation at the various speeds may be attributed to this factor.

POINTS OF FLUCTUATION

With the use of the timing wave, the point at which the right arm entered the water was marked on the recording paper. Figure VI, is a picture of some recordings. The top recording is of Subject 1 using the glide stroke and the slow tempo at zero velocity. The bottom recording is of the same subject using the continuous stroke with the same tempo and the same velocity. By studying underwater motion pictures of the three subjects while swimming both types of stroke, the relative position of one arm to the other, the position of the head, and the amount of roll of the body during various phases of the stroke were determined.

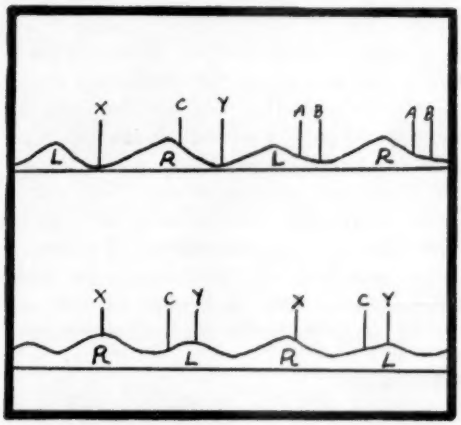

FIGURE VI. Points of Fluctuation While Swimming Both Strokes at the Slow Tempo, Zero Velocity, Subject 1. *Key:* A B—Period during which neither arm is pulling; C—Point at which inhalation is made; R—Force created by right arm pull; L—Force created by left arm pull; X—Point at which left arm entered the water; Y—Point at which right arm entered the water.

Each stroke when swum by the three subjects followed a general pattern as described below. In the glide stroke one arm was held in the extended glide position until the other arm completed both the pull and the recovery

phases. This left a period of time during the recovery phase when the arms were contributing nothing to the forward speed of the body and the kick was the only propulsive force. This point is represented by the space between *A* and *B* in Figure VI. In the continuous stroke the movement of the arm was never completely stopped after it entered the water. The pulling arm in the cases of all three subjects was over half through its pull or had passed a 90° angle to the longitudinal plane of the body when the recovering arm entered the water. The point at which the left arm entered the water is represented by *X* and the point at which the right arm entered the the water is represented by *X* and the point which the right arm entered the water by *Y* in Figure VI. In both strokes, the maximum deviation of the head from the plane of the body and the maximum roll of the body was experienced when the swimmer was taking a breath. This point is shown by the points marked *C* in the illustration. On the basis of the drag measurements taken while the subject was rolling, this would appear to be the point at which the greatest resistance would have been experienced.

In all three subjects, when swimming either the continuous or the glide stroke, the arm on the breathing side created the most propulsive force. Subject 1 breathed to the right and Subjects 2 and 3 to the left. All three subjects were right-hand dominates. The stronger arm, as determined by the amount of weight each could lift with a supine straight-arm pullover, was the arm which created the most propulsive force. From the preceding discussion, it would appear that a swimmer using the continuous stroke should breathe on the side of the weaker arm. In this way, the maximum point of resistance would occur at about the same time as that of maximum propulsion. Thus, less fluctuation in the effective-propulsive force would result. However, when swimming the glide stroke the opposite is true. The swimmer should then breathe on the side of his stronger arm in order that the maximum amount of force may coincide with the maximum amount of resistance.

The maximum propulsive force of the stroke—or the highest points of the plots of the surplus-propulsive force in Figure VI—was reached when the pulling arm was at a 90° angle to the longitudinal axis of the body.

Summary and Conclusion

By means of an apparatus which was designed to tow or release a swimmer at ten controlled velocities, the drag, the effective-propulsive or surplus force, and the fluctuation in propulsive force that three expert swimmers created at the velocities tested was measured and recorded.

The drag of one subject, towed in four different positions, was also measured in order to study the degree of resistance accompanying each position. The two strokes—the glide stroke and the continuous stroke—were tested at two tempos—an average sprinting tempo of one complete arm cycle per 1.20 seconds and an average 1500-meter race tempo of one complete arm cycle per 1.74 seconds. The amount that the effective-propulsive force fluctuated from maximum force to minimum force was compared.

On the basis of the data, the following conclusions seemed justifiable:

1. The four drag positions tested created resistance in the order in which they are listed below from the least to the greatest: prone position, side position, position while being rolled by an external force, and a self rolling position.

2. The point at which the bow wave appeared and its size did not seem to be affected by the position in which the swimmer was being dragged.

3. The continuous stroke created more effective-propulsive force than did the glide stroke for the same tempo and velocity.

4. The continuous stroke was the fastest stroke over the distance tested, which was ten yards.

5. As the surplus force decreased at the higher speeds so did the amount of fluctuation from minimum to maximum force.

6. The glide stroke created more fluctuation in force than did the continuous stroke at the same velocity and stroke tempo.

7. When the continuous stroke was swum, the maximum surplus-propulsive force created by the weaker arm was probably decreased by two factors: the decreased efficiency of the arm pull because of the existence of an angle which decreased muscular efficiency, and the presence of the increased resistance the body created at this, the maximum point of roll. Thus, when swimming the continuous stroke, a swimmer should breathe on the side opposite his stronger arm.

8. When swimming the glide stroke and breathing on the side of the stronger arm, the maximum roll occurs when the swimmer is pulling with his stronger arm. This tends to decrease the difference between the maximum forces created by the stronger and weaker arm. This method of breathing should, therefore, be used when swimming the glide stroke.

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(Submitted 11/21/53)

Effect of Prescribed Abdominal Exercises on Dysmenorrhea in College Women

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Abstract

In this study thirty-six college Freshmen who suffered from moderate or severe cases of primary dysmenorrhea were tested for abdominal strength and endurance and then required to perform daily specified abdominal exercises for a minimum of eight weeks. Upon being re-tested it was found that through an abdominal exercise program there is an increase in abdominal strength and endurance which is significant at the .01 per cent level of confidence and that approximately 87 per cent of those showing improvement in abdominal strength and endurance showed a decrease in one or more factors indicative of the severity of dysmenorrhea.

WE ARE CONCERNED here with primary or intrinsic dysmenorrhea, which has been defined by Novak (5) as "the menstrual pain so often observed in the entire absence of any anatomic abnormality of the pelvic organs." The chief etiological factors proposed by previous research and empirical thought have been psychic and emotional, endocrine imbalance, fatigue, constitutional factors, postural defects, and weak abdominal muscles. The research into the latter and into exercise therapy reveals the following facts.

Miller's study (4) showed a reduction in dysmenorrhea which was associated with an improvement in body mechanics and muscle tone. This was effected through a course in physical education and by corrective exercises. He points out that the pre-menstrual stage is accompanied by congestion of the pelvic organs and that skeletal muscle tone is indicative of the tone of the circulatory system; thus, the dull steady pain of congestion accompanies the dysmenorrheaic with poor muscle tone. Bell and Parsons (1) also found a reduction in dysmenorrhea in college women which was accomplished by an exercise program. They attributed the improvement to better muscle tone and to better hygiene.

The Mosher Exercise, which is an abdominal exercise; the knee-chest position, which is designed to relieve congestion in the pelvic organs; and the Billig Exercise (2) are well known and suggested exercises to relieve dysmenorrhea (1, 2, 3). Each of these exercises is an exercise involving the use of the abdominal muscles.

It is therefore the purpose of this experiment to study the effect of specific abdominal exercises on dysmenorrhea in college women.

Procedure

SUBJECTS

Only Freshmen students who were suffering monthly from moderate and severe primary dysmenorrhea were used in this study. Dysmenorrhea was classified as moderate if the students spent up to four hours in bed, and as severe if they spent four hours or more in bed in spite of simple relief methods.

On the basis of health records and class attendance, students suffering from dysmenorrhea were chosen. Each student was interviewed by the authors and only those students were taken for the study who were still suffering each month. The study was conducted the second semester of the school year, and by that time many of the Freshmen, undoubtedly because of psychological and emotional factors and improved health habits, were completely relieved of pain. Thus, from the 150 original subjects, 86 were chosen who fulfilled the above qualifications of the experiment. Of the 86 chosen, many did not follow through with the exercise program, some had operations, and others for various reasons could not complete the study. Therefore, there were 36 subjects who completed the experiment.

TEST OF ABDOMINAL STRENGTH AND ENDURANCE

Each subject was tested for abdominal strength and endurance, as expressed in inch pounds of work, by a machine designed specifically to measure such strength (6). Essentially, the test consists of the subject performing a sit-up from a hook lying position (see Figure I). A bar, fastened to a movable lever of a resistance coil, is placed across the subject's chest, two inches below shoulder level. In this position, the subject performs a sit-up, working

FIGURE I. Position of Subject While Being Tested for Abdominal Muscle Strength and Endurance.

against a 20-pound resistance. This position is held for 30 seconds. Abdominal strength is determined by the height of the sit-up, and endurance by the character of the curve. Results are calculated in inch pounds of work in the following manner.

CALCULATION OF RESULTS

Abdominal Muscle Strength (see Figure II).

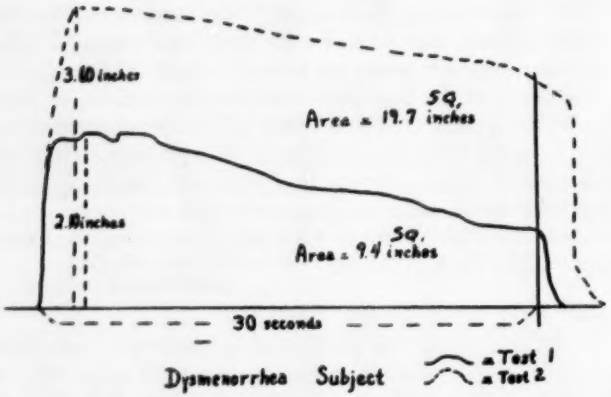

FIGURE II. Strength and Endurance Record of Subject Before Taking Abdominal Exercises (Test 1) and After Eight Weeks of Exercises (Test 2).

(a) A line is drawn along the abscissa of the curve, the length of which measures 30 seconds of recorded strength.

(b) The highest point on the curve is noted, and a line is drawn perpendicular to the baseline and in measured in inches.

(c) By the following formula the strength is converted into inch pounds of work.

$$W = D \times R \times \frac{L}{S}$$

W = Work in terms of inch pounds

D = Height of the perpendicular line on graph paper.

(The apparatus was designed so that the height of the perpendicular line was equal to the height of the bar lifted by the subject.)

R = Resistance. (This refers only to the additional 20 pounds weight and does not include upper trunk mass.)

L = Length of movable lever (B) of resistance coil (44 inches).

S = Length of movable lever from resistance coil to string attachment (B_1) on lever (33 inches).

(d) From Figure II, test 1, work is calculated as follows. The height the subject lifted the bar was 2.10 inches. From the formula $W = D \times R \times \frac{L}{S}$, strength is as

follows:

$$W = 2.10 \times 20 \times 1.33 \left(\frac{L}{S}\right)$$

W = 55.86 inch pounds (abdominal muscle strength).

Abdominal Muscle Endurance. Strength endurance as used here means the average strength for 30 seconds as expressed in inch pounds of work and will be referred to as Strength Endurance Index (SEI).

(a) The length of the record for 30 seconds of work is marked off on the chart.

(b) The periphery of the area described on the kymograph of the recording unit is measured by a planimeter and recorded as square inches.

(c) The area recorded in one square inch records 1.33 inch pounds of work.

(d) Work as determined by a one-inch high record is

Work (Strength) = 1 inch $\times$ 20 lb. $\times$ 1.33

Work = 26.6 inch pounds.

(1) One inch along the baseline measures 5 seconds of abdominal muscle strength endurance.

(2) The abdominal strength endurance (SEI) of 1 square inch would thus measure 26.6 inch lb. $\times$ 5 seconds (Impulse = force $\times$ seconds) 133 inch lb.

(e) The SEI of the entire area is

$$SEI = \frac{\text{Area} \times 133}{30 \text{ (seconds)}}$$

(f) In Figure II, the Strength Endurance Index is

Area recorded for 30 seconds 9.4 sq. in.

$$SEI\ 9.4 \times 133 \frac{125}{30} = 41.67 \text{ in lbs./sec.}$$

Reliability. Reliability by the test re-test method was found to be .79 for abdominal strength and .83 for endurance.

RECORD OF MENSTRUAL PERIOD

Before starting the experiment, each student filled out a chart in regard to her menstrual period, indicating the severity of the pain, the number of hours spent in bed each month because of it, and other procedures during the menstrual period. This chart was kept by the subject and at the end of each menstrual period it was turned in to the instructor so that a complete record of the menstrual cycle was kept.

EXERCISES

All students chosen for the experiment met twice a week under the supervision of one of the authors for a class designated as Special Exercises. The class met for five to ten minutes, and only abdominal exercises were given during that time. The exercises were done for endurance as well as strength, and each girl tried to beat her own record, within a certain time limit. During the week each girl was told to practice her abdominal exercises for five minutes a day (see Appendix). For all but four girls, this was the only exercise that they took in their physical education class. The four who took another class were enrolled in the eight-week class in bowling, basketball, fencing, and swimming respectively.

RETEST OF ABDOMINAL MUSCLE STRENGTH AND ENDURANCE

The exercises were continued for a period of eight weeks. At the end of this time the 36 subjects were retested for abdominal strength and endurance. Fifteen of these students continued in the Special Exercise class for an additional eight weeks. The data for this last period are tabulated separately.

Results and Their Interpretation

From Table 1 it is apparent that there is an increase in abdominal muscle strength and endurance as a result of performing abdominal exercises regularly over a period of time. This increase in strength is statistically significant (see Table 1). The increase in strength and endurance was computed for the difference between means.[1]

TABLE 1

Abdominal Strength Record of Subjects Showing Increase in Strength After Exercise

Record	36 Subjects, 8 Weeks		15 Subjects, 2d 8 Weeks	
	Strength	Endurance	Strength	Endurance
M	18.1	16.25	11.53	11.67
SD	14.6	12.00	17.75	13.10
Range	−6 to +61	−4 to +52	−13 to +51	−4 to +34
t	5.03	5.23	2.03	2.16
Level of Significance	.01%	.01%	0.07%	0.05%

Of the 36 students completing the first eight weeks of the experiment, 18 were originally classified as severe cases and 18 as moderate. Table 2 shows a comparison of the results (with respect to increase, decrease, or no change in factors related to the severity of dysmenorrhea) (see Table 2).

TABLE 2

Summary of Results Showing the Number of Case Studies That Fall Into Each Category

Group Classification (8 Weeks)	Abdominal Strength		Abdominal Endurance		Severity of Pain			Hours In Bed			Amount of Drugs Used		
	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Same	Inc.	Dec.	Same	Inc.	Dec.	Same
Severe (18)	18	0	18	0	0	12	6	1	14	3	0	13	5
Moderate (18)	17	1[1]	17	1[1]	1	13	4	2	14	1	0	10	5
								(1 never went to bed)			(3 did not take drugs)		
Total (36)	35	1	35	1	1	25	10	3	28	4	0	23	10
(2nd 8 Weeks)													
Severe	6	3	6	3	2	5	2	1	5	3	0	3	6
Moderate	6	0	6		0	2	4	0	3	3	0	3	3
Total (15)	12	3	12	3	2	7	6	1	8	6	0	6	9

[1]This was the same girl and since the rest of her results were all favorable, we question the test results in this case. Unfortunately, we were unable to get her back for a retest.

$$t = \frac{\text{M of Diff.}}{\sqrt{\frac{\Sigma (d - d)^2}{N - 1} \frac{(1)}{N}}}$$

From the results in Table 2 one can see that approximately the same number of students in each classification showed a decrease in the severity of the symptoms of dysmenorrhea as they improved in abdominal strength.

In Table 3 one can see the number of cases who failed to show any decrease in the severity of dysmenorrhea in spite of an increase in abdominal strength as well as the number who showed a decrease in one or more factors related to severe dysmenorrhea. Approximately 92 per cent did show less severe symptoms, whereas 8 per cent showed no change. Of those who improved, 50 per cent showed a decrease in all three symptoms of dysmenorrhea (see Table 3).

TABLE 3

Summary Showing by Number of Case Studies the Improvement Made in the Three Factors Related to the Severity of Dysmenorrhea, Severity of Pain, Number of Hours in Bed, and the Use of Drugs

Group Classification	Improvement in 3 Factors	Improvement in 2 Factors	Improvement in 1 Factor	Improvement in 0 Factors
8 Weeks				
Severe	8	6	2	2
Moderate	10	3	4	1
Total (36)	18 (50%)	9 (25%)	6 (16.6%)	3 (8.3%)
2nd 8 Weeks				
Severe	1	4	1	3
Moderate	1	1	1	3
Total (15)	2 (13.3%)	5 (33.3%)	2 (13.3%)	6 (40%)

Of the 18 who improved in all three factors, it is of some interest to note that three had no symptoms of dysmenorrhea at the end of the test. Two of these case studies had originally been classified as having severe dysmenorrhea, and one as having moderate dysmenorrhea.

Improvement in strength and endurance was noted at the end of the second eight weeks, but the level of significance was lower. A decrease in the symptoms of dysmenorrhea also occurred in 60 per cent of the cases. By the end of the first eight weeks, several had reached a level of improvement which was maintained in the other 40 per cent of the cases.

Conclusions

On the basis of findings of this study, we can conclude that through an abdominal exercise program of eight weeks there is an increase in abdominal strength and endurance which is significant at the 0.1-per-cent level of confidence.

Secondly, we can state that approximately 91 per cent of those showing improvement in abdominal strength and endurance showed a decrease in one or more factors indicative of the severity of dysmenorrhea—amount of pain, number of hours spent in bed, and quantity of drugs used.

Finally, we found some additional improvement in about 60 per cent of those who continued for an additional eight weeks, but 40 per cent showed no change in symptoms even though abdominal strength and endurance increased.

APPENDIX

Abdominal Exercises

I. Mild Abdominal

Start: Lie on back, knees flexed to a right angle, feet flat on floor approximately 12 inches apart and hands on front of left thigh.

Perform: With feet flat on floor, raise head and upper trunk from floor, slide hands along left thigh and touch left knee. Lower head and trunk so that back and head touch floor. Immediately repeat exercise, touching right knee. Then repeat exercise, touching both knees. Do 3 times and gradually increase to 9 times. When 9 can be performed, progress to *Moderate* exercise.

II. Moderate Abdominal

Start: Same as for Mild exercise, except that arms are folded horizontally across chest with hands grasping ribs.

Perform: With feet flat on floor, raise trunk to a sitting position. Return to starting position, touching back and head to floor. Repeat wihout a pause. Do 4 times and gradually increase to 12 times. When 12 can performed, progress to *Vigorous* exercise.

III. Vigorous Abdominal

A. *Start:* Same as for Moderate exercise, except that hands are clasped behind neck, elbows on the floor.

Perform: With feet flat on floor, raise trunk and touch right elbow to left knee. Return to starting position. Repeat without a pause, touching left elbow to right knee. Do 4 times. Increase gradually to as many times as possible. Proceed to next exercise when this one can be done a fair number of times.

B. Back lying with knee bent to chin—double knee circling 10 times each direction—(gradually increase)—emphasize strong pull toward chin so that pelvis comes off floor.

Five minutes daily should be spent on these exercises for 3 months.

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(Submitted 6/8/54)

Prediction of World Records in Running Sixty Yards to Twenty-Six Miles

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Abstract

Previous attempts to formulate the mathematical relationship between velocity and elapsed time (or distance) in running records have failed to account for the sprint events and have been empirical rather than theoretical. In the present study, a velocity equation is developed which consists of the sum of three exponential terms having fatigue constants or *k's* characterizing the muscle energy supply systems—the alactate and lactate oxygen debts and the glycogen reserve. A subtractive exponential term represents the acceleration factor in the sprints. Using this equation, record speeds for 100 yds. and longer distances are predicted with an error of less than 1 per cent; for the 60 meter—60 yd. sprints, with errors of 2 and 3 per cent.

IN HIS 1924 HERTER LECTURES at the Johns Hopkins University, the distinguished physiologist A. V. Hill called attention to the fact that "Some of the most consistent physiological data available are contained, not in books on physiology . . . but in the world's records for running . . ." (2, *p. 98*). Lietzke (8) has recently reviewed the attempts that have been made, beginning in 1905, to derive a descriptive mathematical relationship between distance and running time. None of these attempts have in his opinion been successful, although the mathematical forms used have ranged from a modified parabola to a semi-logarithmic hyperbola.

Lietzke has given a more general and more accurate formulation of the relationship than any of the others. The distance y as a function of the time t is predicted through the use of the parabola

$$y = a\,t^{k} \qquad (1)$$

where the units conversion factor a has the magnitude 11.72 for yard-second units and k is 0.914, within the interval between the mile run and the Marathon distance of 26.2 miles. With different curve constants, he is able to use a separate form of the formula for the interval between the 440 and the mile, but has no success at all with the shorter distances. Lietzke as well as some of the other investigators cited by him have mentioned the importance of

"physiological relationships," but their formulae are strictly empirical in nature.[1]

Purpose of the Study

If records in running competition are in fact determined to an important extent by physiological processes, it should be possible to derive from physiological factors a formula that will predict the runner's speed as a function of time for any of the distances used in competition—the sprints and middle distances as well as the mile events and the Marathon. This would of course require adequate knowledge of the crucial physiological capabilities of the runners who made the records. Such information, unfortunately, is not available. However, it is possible to set up some generalized mathematical formulations representing the physiological factors. The resulting formula can be tested as a predictor of the time-distance records, and the underlying hypothesis can be tested as a prediction of the pattern of the records as a funtcion of distance or elapsed time.

Theory and Method

The groundwork for the study will be found in previous articles giving mathematical expression for lactate and alactate oxygen debt (1, 4, 5) and for the time-velocity relation in "all-out" running (3). Since the *integral* or time-distance curve is notoriously insensitive as pointed out by Lietzke, and moreover is *theoretically incorrect* in this particular problem as will be explained later, the *derivative* or rate curve will serve as the basis of the analysis. It will be most convenient to plot this curve with a logarithmic ordinate, using linear or arithmetic time units for the abscissa.

Acceleration Factor. The upper curve in Figure I gives the average velocity for the championship records for the sprints. (In the actual curve-fitting, a wider graph was used, in order to include the middle distances up to the 880-yd. and 1-km. records). By drawing a smooth line through the highest points (ignoring the 300 yd. and 300 meter distances, plotted as crosses, because they have been largely neglected in competition), a curve is obtained which is remarkably similar to the 300-yd. "all-out" velocity curve recently reported (3).

It will be seen that the velocity (defined as speed in the forward direction) becomes progressively less as the distances decrease from approximately 200 yd. This is because it takes time to accelerate the mass of the runner; at the

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[1]This statement is somewhat unfair to A. V. Hill, since his work on sprint velocity led directly to the inclusion of the acceleration factor in the present study. Moreover, he has used oxygen metabolism data to estimate speed within certain distance ranges.

"The Ultimate of Human Effort," an article by Brutus Hamilton (*Amateur Athlete*, Feb. 1935), should be added to the Lietzke reference list, and his date for the pioneer Kennelley study should be changed to 1906. George P. Meade, another pioneer in the systematic study of World Records, has kindly called the writer's attention to a later article by Kennelley (*Proc. Am. Acad. Arts and Sciences*, Aug. 1926) in which the 3:58 mile was predicted.

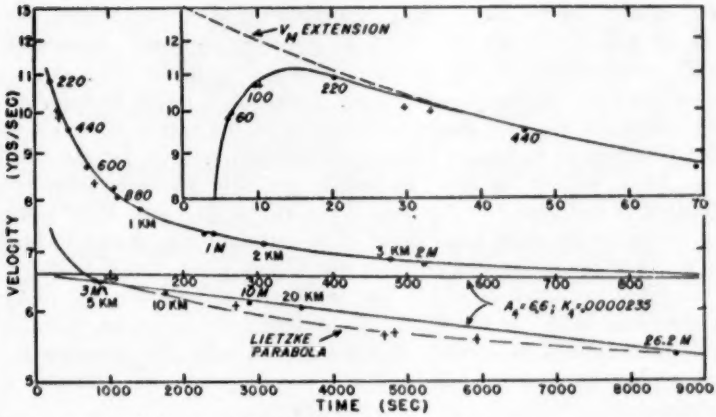

FIGURE I. Average Velocity of World Record Times. The crosses represent "sub-standard" records.

start, his velocity is zero. Acceleration would progress linearly and without limit, as a function of time, if it were not for the "energy loss" and viscosity factors that impose what may be considered as a counter force that is proportional to the speed of the runner. The net outcome is that the runner approaches some limiting velocity v_m in accord with an exponential law (3).

It is easiest to evaluate this subtractive exponential term graphically by extending the main velocity curve leftward until it reaches the ordinate. It may be seen in Figure I that the intercept of this extension is 13.1 yd/sec. Now, if one substracts the observed velocities from this extended v_m curve, a series of *differences* as a function of time are obtained. These differences plot out as a straight line on a semi-log graph, and it requires 2.79 sec. for the initial magnitude of 13.1 to drop to half this amount. (Naturally, this plot of the differences must be made on a greatly expanded time scale. See upper right curve of Figure II.) From this *half-time* (3) the exponent k_1 is determined as 0.693/2.79 or 0.248, and the coefficient a_1 is of course 13.1. The observed k_1 is considerably smaller than the k_1 of 0.75 found in all-out running, but that is because the latter was determined from the *instantaneous* velocity at various time stations whereas in the present case it is determined by the *average* velocity of the runner when he sprints various distances. For that reason, it does not have a rigorous theoretical meaning, but it *is* an acceleration-energy loss component and does serve its purpose in the formula.

Glycogen Depletion Factor. The next step is to derive a component for the physiological factor determining the velocity at long distances of the range 3 to 26 miles. It is common knowledge that a run of only a few miles has no influence on the blood sugar level, but a 26-mile run causes a serious drop, indicating considerable depletion of the glycogen reserve. For example, Morehouse and Miller (9, *p. 53*) in discussing this matter, state that in the Boston

Marathon of 1924 the blood sugar concentration of several runners was reduced by a half. In his discussion of glycogen depletion, Karpovich (6, *p. 156*) mentions experiments showing marked drop in the blood sugar after 3 hours exertion. In very rough figures, therefore, it might be expected that the half-time for glycogen depletion would be in the region of 5 or 6 hours.

The lower curve of Figure I gives the average velocity for the long distances. Here, we are fortunate in having available the remarkable records of Zatopek at distances ranging from 5 km. to the 26.2 mile Marathon. The latter serves as the right hand point of the straight line drawn through or close to his other points and through the Haegg 5 km. and 3 mile records. The intercept magnitude a_4 of this line is 6.6 and its half-time is 8.19 hrs. so k_4 (in seconds units) is 0.0000235. Considering the half-time, it seems not overly presumptious to identify this component with the glycogen supply. Since it plots as a straight line on a semi-log graph, the function is exponential.

The crosses in the figure represent existing records at intermediate distances. The velocities at the 15-mile and 25- and 30-km. distances (run by others) lie on the Lietzke parabola (dashed line), but the Zatopek records for the 10-mile, the 1-hour and the 20-km. events are considerably above the parabola and on the exponential line.

Lactate and Alactate Energy Factors. Next in importance as sources of energy are the lactate and alactate oxygen debts, the former representing a maximum store of 75 to 90 kilocalories and the latter perhaps 25 or 30. Exercise metabolism studies from this laboratory (1, 4, 5) have reported half-times of 215 sec. and 30 sec. for these functions. It can be expected that they will be involved in the remaining portion of the curve analysis.

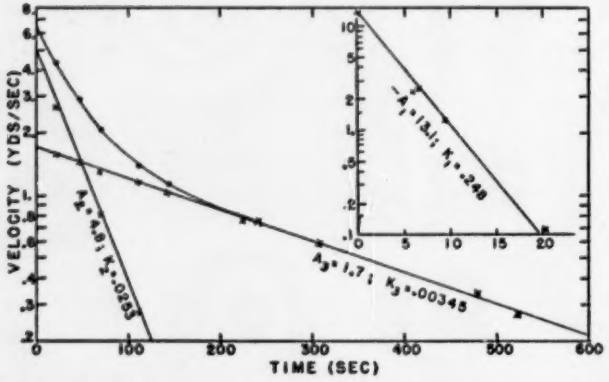

FIGURE II. Exponential Curve Analysis. The main figure shows the two-component composition of the residuals after subtracting the a_4—k_4 component from the velocity curve. The insert figure shows the residuals after subtracting the sum of the three positive components from the sprint velocity curve. (Note that all components add vertically since these are semi-log graphs).

For the analysis of this part of the velocity curve, the records for the range 220 yd. through 2 miles have been plotted as the middle curve in Figure I, including the a_4—k_4 component which appears as a straight line just below the curve. (Although that component looks like a base line due to the expanded time scale, it actually has a slight slope, dropping from 6.6 to 6.5 in 750 sec.) The first step is to draw a smooth curve through the points and then subtract the a_4—k_4 component vertically from this curve at progressive intervals of time. The differences so obtained are then plotted in a separate semi-log graph (Figure II). The lower limb of the difference curve is accounted for by the straight line $a_3 = 1.7$, $k_3 = 0.00345$, which has a half-time of 201 sec. Subtracting this component from the difference curve gives a series of points that fall on the straight line $a_2 = 4.8$, $k_2 = 0.0253$, with a half-time of 27.4 sec.

Results

Equation for Speed of Runner. It is now possible to set up the rate equation

$$dy/dt = a_4e^{-k4t} + a_3e^{-k3t} + a_2e^{-k2t} - a_1e^{-k1t} \qquad (2)$$

which gives the velocity of running in yd/sec for any elapsed time within the region 5 sec. to 10,000 sec. It may be noted that the subtractive component a_1—k_1 has such a short half-time that it may be neglected for distances longer than 300 yd. or for times that are greater than 30 sec.; also, the a_2—k_2 component contributes only 0.01 yd/sec at 1 mile and may be neglected thereafter. Somewhere between 5 and 10 km. the a_3—k_3 component also drops out. The sum of the three positive components at any time t gives the dashed line leftward extension in the upper curve of Figure I. This is the velocity that would have been attained if the runner had not for physical reasons lost considerable time in accelerating his body mass to full speed.

Errors of Prediction. Since the graphs cannot be read with sufficient accuracy to determine the errors, they have been included as part of the tabulation in Table 1. The largest errors, of the order of 2 or 3 per cent, are at the 60-m. and 60 yd. distances. At 800 meters the observed velocity is 1.3 per cent faster than predicted by the equation. With these exceptions (and they represent rather small deviations), the errors are small—less than 1 per cent. It is interesting that the recent 3′:58″ mile run by Landy is only 0.8 per cent faster than predicted by the equation, which was set up to fit the 1954 *World Almanac* data. It is anticipated that eventually the records for other distances will also move up to lie above the curve, but it will probably be a number of years before any important modification of the curve-constants will be necessary.

Justification of Exponential Analysis. Any curve that is characterized by regularly decreasing curvature can be described by a mathematical function consisting of a sum of exponentials, provided that the number of terms in the polynomial approaches the number of points to be fitted. Equation 2 is not of that category.

TABLE 1

Predicted and Observed Velocities

Event Time (Sec)	60 yd. 6.1	60 m 6.6	100 yd 9.3	220 yd 20.2	440 yd 46.0	600 yd 69.2	0.8 KM 106.6	880 yd 109.2	1 KM 141.3	1.5 KM 223.0
$a_1e^{-k_1t}$	−2.89	−2.60	−1.31	−0.09	—	—	—	—	—	—
$a_2e^{-k_2t}$	4.12	4.06	3.79	2.88	1.50	0.83	0.32	0.30	0.13	0.02
$a_3e^{-k_3t}$	1.68	1.67	1.65	1.58	1.45	1.34	1.18	1.17	1.04	0.79
$a_4e^{-k_4t}$	6.60	6.60	6.60	6.60	6.60	6.59	6.59	6.59	6.58	6.57
Total (yd/sec)	9.51	9.73	10.73	10.97	9.55	8.76	8.09	8.06	7.76	7.38
Observed (yd/sec)	9.83	9.94	10.75	10.89	9.57	8.68	8.20	8.05	7.73	7.35
Error	−3.2%	−2.1%	−0.2%	0.7%	−0.2%	0.9%	−1.3%	0.1%	0.4%	0.4%
Event	1 mile	2 KM	3 KM	2 mile	3 mile	5 KM	10 KM	10 mile	20 KM	26.22 mile
Time (min)	4	5	7	8	13	13	29	48	59	143
(sec)	1.4	7.0	58.0	40.4	40.4	58.2	2.6	12.0	51.7	3.2
$a_3e^{-k_3t}$	0.74	0.59	0.33	0.28	0.10	0.09	—	—	—	—
$a_4e^{-k_4t}$	6.57	6.56	6.53	6.52	6.46	6.44	6.32	6.17	6.07	5.39
Total (yd/sec)	7.32	7.15	6.86	6.80	6.56	6.53	6.32	6.17	6.07	5.39
Observed (yd/sec)	7.29	7.13	6.86	6.76	6.50	6.53	6.27	6.14	6.09	5.38
Error	0.4%	0.3%	0.0%	0.6%	0.9%	0.0%	0.8%	0.5%	−0.3%	0.2%

Consider the a_4—k_4 component (the lower curve in Figure I). It is obvious by inspection that the Zatopek records at 5, 10 and 20 KM and 10 miles establish a straight line within the range 1,000 to 4,000 sec., and this line can be extended to his marathon record at 8,583 sec. (The 10-km. point is about 0.9 per cent low; Zatopek remedied this minor defect in June 1954 by running the distance in 28′:54.2″, which is rather precisely on the line.)

A series of residuals is left after this component has been removed from the observed velocities within the range from 20 sec., when the influence of the start is just dropping out as a factor, to 1,000 sec., where the straight line component began. This series forms a curve (Figure II). It resolves into two and only two components, as can be seen by the x symbols which represent the fractionation of the observed residual velocities into two straight-line functions. There are many events within this range. The first of the components is defined by 5 points (one of these, at 141 sec. with the ordinate at 0.12, does not show on the graph). The other component is defined by 10 points. It should be remembered that a *straight* line in the semi-log graph means that the component is exponential—it would not plot as a straight line on an arithmetic graph.

The insert graph of Figure II gives the resolution of the residual velocities for the sprints, after subtracting the sum of the computed last three components. The x's in this figure therefore represent observed values. While these points do not fall exactly on a straight line, they are certainly not off very far. It should be realized, also, that the k's are all separated by approximately one order of magnitude (two magnitudes in the case of k_4).

Time and Speed at a Specified Distance. Predicted time can most readily be estimated graphically, by plotting a time-distance curve similar to an integral curve, the distances on the graph being computed as the product of time and the corresponding rate from Equation **2**. It is desirable to draw this figure on a log-by-log graph since the points will then lie very nearly on a straight line for distances greater than 220 yds. as can be seen in Figure III. The scale of this graph is magnified about 8 times as compared with the corresponding Lietzke figure, hence the errors are more noticeable. Estimation of speed in yd/sec as a function of distance can also be made graphically, but no straightforward mathematical formula is available because the exponential equation cannot be solved for t.

Discussion

Lietzke Formula. Equation **1** has the advantage of flexibility. While the first derivative of this expression, namely

$$dy/dt = akt^{k-1} \tag{3}$$

does *not* give the speed of the runner, the mathematical statement of the average speed

$$y/t = at^{k-1} \tag{4}$$

differs from Equation 3 only by the constant k. Moreover, the original equation is easily solved for t, since

$$t = (d/a)^{1/k} \qquad (5)$$

which provides a useful formula. Regardless of the mathematical elegance of the parabola, however, it has certain serious deficiencies. The curve constants have no physiological meaning. It is an empirical formula, and like other empirical formulae can be used only within a restricted range of data. At the practical level, it fails to predict with adequate accuracy. If the curve constants are chosen to fit the distance range 1 to 3 miles, they also fit the Marathon, but the predicted velocities for the 10-, 15-, and 20-kilometer runs lie considerably below the Zatopek records as was shown in Figures I and III. If the curve constants are chosen to fit these Zatopek records, the formula

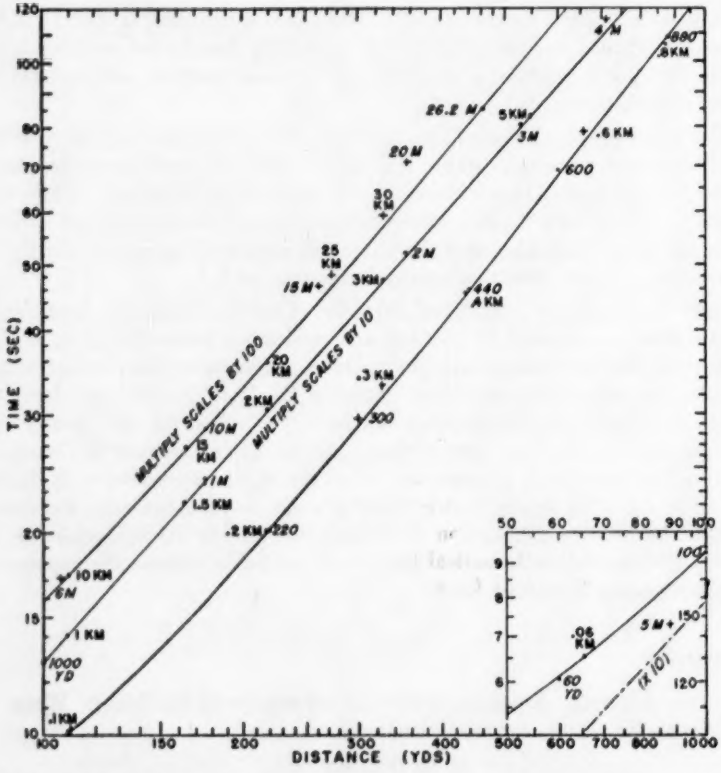

FIGURE III. Log-by-Log Plot of Time-Distance Relationship. The smooth curves represent the product of time and velocity computed from Equation 2. Note that the fragment of the curve 1200-1600 sec. with the sub-standard 5 mile is in the lower right corner (broken line). Other sub-standard records are identified by crosses.

fails to predict the Marathon and also the range 1 to 3 miles. It should be mentioned that while Leitzke (8) gave Equation 4 as the rate formula, his velocity curves are simply smooth curves connecting the points and are *not* based on his rate formula.

Power Output. In a recent note, Katz (7) has used a parabola to describe the energy output in horsepower of athletes during hill climbing. Velocity (i.e. the distance traveled per unit time) can be considered as related to square root of the power output, although it does not explicitly take into account the variation in frictional resistances as a function of speed. For this reason, the k obtained in the Katz analysis would be expected to be different. It is 0.784 compared with the Lietzke k of 0.914. While Katz states that his points "fall on a surprisingly straight line" over a 5–magnitude range of time, he does not give the precision of fit of his curve.

Actually, the fit is rather poor. He has drawn his curve through the highest and lowest power outputs. The intermediate observations of horsepower and their per cent deviations from his curve are shown in Table 2. Since the errors are large, the points *could* be fitted by a parabola, or by some other function such as an exponential formula. Nevertheless, his analysis is of interest, since it illustrates the possibility of analyzing hill-climbing as well as level-ground performance.

TABLE 2

Errors in Predicting Power Output in Hill Climbing by the Katz Equation

Time (sec)	2.4	4	30	44	225	342	1320	4110	9060
Observed H.P.	1.70	1.32	0.94	0.87	0.44	0.57	0.45	0.27	0.24
Predicted H.P.	1.60	1.44	0.93	0.85	0.60	0.55	0.41	0.32	0.27
Error (%)	6.25	8.26	1.08	2.36	26.70	3.64	9.77	15.62	11.12

Integral Curve. Equation **2** can be integrated by standard methods. The resulting formula for the distance y at any time t is

$$y = \frac{a_4}{k_4}(1 - e^{-k_4 t}) + \frac{a_3}{k_3}(1 - e^{-k_3 t}) + \frac{a_2}{k_2}(1 - e^{-k_2 t}) - \frac{a_1}{k_1}(1 - e^{-k_1 t}) \quad (6)$$

While this formula gives the area under the rate curve, and *would* give the distance y attained by the runner at time t if he ran his race in the velocity pattern described by the rate curve, the facts of the matter are that his velocity pattern is not of this form. Consider for example the recent 3 min. 58 sec. mile run by Landy. He ran the first quarter in 58.5 sec., the second in 61.0, the third in 60.5 and the last in 58.0, all of these being within 2.5 per cent of his average velocity of 7.4 yds/sec. Had his pattern of running been as specified by the rate curve, his average lap velocities would have been about 10.2, 8.3, 7.7 and 7.4 yds/sec. and he would have reached the tape *more than a half-minute* before he actually did. Of course no runner in his right

mind would attempt to pace his mile in any such manner, because it is too inefficient physiologically (3).

Instantaneous Velocities. The integral curve (Equation **6**) and the exponential rate curve (Equation **2**) are both effective in predicting the instantaneous distances and velocities in *all-out* running, although the curve constants are of course somewhat different in that situation. Using only the a_1—k_1 and a_2—k_2 components, a rather good fit was secured for the curves of 24 track men and 30 other students who ran as fast as possible *throughout* a distance of 300 yards. It was observed that the velocity curve tended to flatten out somewhat during the last 80 yds., although the available data did not permit an analysis of the phenomena. It is obvious by inspection of those data (3) that the addition of the a_3—k_3 and a_4—k_4 components would give an almost exact description of this flattening of the curve.

Energy Supply for 24-Hour Run. It is known that continuous work of many hours' duration without food intake draws on the body fat for energy supply (6, *p. 46*). Theoretically, therefore, a fifth component should be added to Equation **2** in order to describe this process. Only a few data are available to estimate the additional curve constants—Lietzke (8) in his Figure 10 shows a point at 162 miles with a time of 24 hr., and Hill's graph (6, *p. 62*) gives the times for 50- and 100-mile runs. While these data are not World Records in the usual sense, they do give reasonable results when tested with a five-component exponential equation (Figure IV).

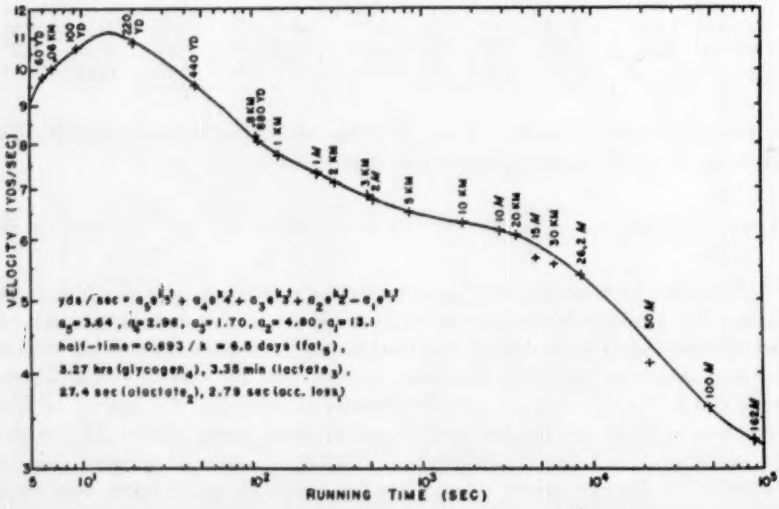

FIGURE IV. Theoretical Time-Velocity Curve. Log-by-Log plot of five-component equation. The Lietzke rate formula (equation **4**) would plot as a straight line in this figure.

The a_4—k_4 component of Equation 2 should consequently be thought of as representing glycogen *and* other unresolved energy supply factors such as fat. The "fat" component is non-limiting and unrecognized for distances shorter than the Marathon, but becomes increasingly important in determining performance in very long runs of 50 miles or more. Total potential energy of each of the energy supply systems, if completely used up, would be equal to a/k (with the appropriate subscripts).

Resolution of the a_4—k_4 component into its two principal factors gives a shorter half-time (3.27 hrs.) for glycogen depletion. The fatigue constants thus become $k_4 = 5.88 \times 10^{-5}$ for glycogen and $k_5 = 1.234 \times 10^{-6}$ for "fat" (including possibly protein). The energy depletion rates of the other components remain unaltered.

Implications of the Exponential Equation. The a coefficients can be given only a very general sort of definition at the present time. They may be thought of as proportional to energy *output*, as expressed by velocity units. Because of differences in metabolic efficiency of the different physiological processes that they represent, they are probably not equivalent units of energy *input.* The k's may be visualized as time-constants governing the rate of energy depletion of each of the energy resources, and imply that the *rate* of depletion of each is always a constant proportion of the undepleted amount still available at any particular instant t after the beginning of the run. Viewed in this manner, the k's may be thought of as physiological fatigue constants governing the decrement in speed as the length of the race increases.

Estimation of Possible Improvements in Records. Hill in 1924, after plotting the World Record velocities against the distances of the events, commented on the remarkable smoothness of the velocity curve: "The relation . . . may be accepted practically as a natural constant for the human race. It would require almost a superhuman effort to change one of the points by 2 per cent" (2, *p. 99*). Others have since been equally venturesome. Since his statement, record speeds in the 220 and 440 have improved nearly 4 per cent; in distances of one mile and greater, the improvements have been well over 5 per cent.

In part this may be ascribed to the greater statistical probability that an unusual performance will be seen in a larger sample. Also, running surfaces as well as techniques may be better; human capabilities may have increased. Whatever the cause, we have no good reason to believe that the end of improvement is yet in sight. Although it is 30 years after Hill's classical work on the physiology of running, we still have insufficient knowledge to estimate dependably the ultimate limits of human performance.[2]

A theoretically meaningful formula that describes accurately the time-distance-velocity relationships *can* be used to pick out which events are presently being run sub-standard with respect to human capabilities, but this is

[2]For a recent discussion of this matter, see A Note on Physiological Limits and the History of the Mile Run, *Research Quarterly* **25**: 483, 1954.

not within itself a very important purpose. Rather, the function of the equation is to co-ordinate various and perhaps widespread bits of knowledge and factual observations in a more and more meaningful manner, the eventual goal being that scientific understanding which alone makes possible the correct and dependable solution of practical problems.

Conclusions

Using the known time-constants or *k's* for alactate and lactate metabolism, and a third *k* crudely estimated from the few facts available regarding glycogen depletion, an equation consisting of a series of exponential fatigue terms has been developed to describe the speed and position of a runner as a function of time. A subtractive term must be included to account for the loss from internal resistance and the development of momentum during the initial acceleration of the runner.

This rate equation makes possible the computation of the average velocity of a runner for distances ranging from 60 yards to 26 miles. World-record speeds and times in the commonly run events can be predicted accurately.

There are indications that the addition of another exponential term to account for energy supplied from body fat will extend the range of prediction to about 150 miles.

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(Submitted 7/19/54)

Effect of Systematic Horizontal-Ladder Exercises Upon Upper Body Strength of Third-Grade Children

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Abstract

Two groups of third-grade children, 66 subjects in all, were given six tests of strength at the beginning and the end of a three-month period. The *t* ratios were computed to determine the statistical significance of the obtained differences between the two groups. The experimental group made statistically significant gains in push-ups, pull-ups, pushing and pulling strength. It is concluded that the horizontal-ladder is an effective apparatus for increasing the strength of third-grade children.

THE PURPOSE of the present study was to determine the effect of systematic horizontal-ladder activities on upper body strength of third-grade children. Although O'Keefe and Fahey (5) recommend that apparatus work be given a prominent place in the elementary school physical education program, little is known about changes in strength resulting from allocating a specified amount of time to practice on apparatus. What are the effects of daily practice with the horizontal-ladder on children of elementary school age? Would a period of ten minutes a day on a horizontal-ladder prove sufficient to give a significant increase in strength over a period of three months?

Capen (1) studied the effects of systematic weight training on strength, athletic power and circulo-respiratory endurance of two groups of college students. He found that Group A, which participated in the weight training program, gained more on the left grip test, while Group B gained more on the right grip test. On the chinning test given by Capen no significant difference was found between the means of the two groups.

Procedure

The subjects were 66 third-grade boys and girls of the public elementary schools in Kansas City, Missouri, ranging from eight years to ten years and eight months. There were two groups, the experimental group of 34 subjects from Mount Washington elementary school, and the control group of 32 subjects from Manchester elementary school. The two groups were of approximately the same socio-economic class. The control was selected from a school that lacked a horizontal-ladder.

On the days that the author was not available, the program of activities for the experimental group was carried out by the classroom teacher under the supervision of the elementary-school principal. The teacher was familiar with

the activities on the horizontal-ladder, since they were a part of the regular physical education program. The activities on the horizontal-ladder for the experimental group preceded the regular games and activities. The total amount of time for physical education activities given to the experimental group was the same as that given to the control group.

The equipment for the experimental group consisted of one outdoor metal horizontal-ladder, 6 feet in height, 16 feet long, and with 15 rungs; and an adjustable indoor wooden horizontal-ladder of the same dimensions as the metal ladder. The study was carried on during the months of January, February, and March of 1953. This necessitated the use of the indoor horizontal-ladder a great part of the time.

At the beginning of the experiment, the two groups were given six tests to determine their upper-body strength. Three months later they were again given the same tests. These tests were the grip strengths of the right and left hands (measured in units of pounds by the grip dynamometer), (4), pull-ups, push-ups, and push and pull strength (measured in units of pounds by the push-and-pull dynamometer). The test for pull-ups was given on the rings in the manner suggested for boys by McCloy (4). Scores in half-movements were given to subjects who could perform half a pull-up but not a complete pull-up. The push-up test was given from the front leaning-rest position, with the score being the number of times that the subject raised his body by extending his arms.

The precision of the dynamometer used in this study was determined by hanging various known weights from the instrument and by checking the readings on the instrument with the weights. The dynamometer recorded 102 pounds with the 100-pound weight. This discrepancy did not affect the study, since the same instrument was used throughout the work. In order to familiarize the subjects with the instrument, an explanation together with a demonstration was given to the two groups. To bring the explanation of testing grip strength down to the understanding of third-graders, the gripping was compared to squeezing another person's hand until one of the two "gives up." The subjects were told that the score on squeezing the dynamometer could be compared with their friends' scores to determine which persons were the stronger. This explanation also provided a motivating factor. On the dynamometer tests, the subjects were given three trials and the mean was recorded. They had one trial each on the push-ups and pull-ups.

The experimental group used the first ten minutes of each physical education period, five days a week, from January 10 to April 10, for the following special exercises, described diagrammatically by McClow and Anderson (3):

1. All the subjects did the maximum number of push-ups for a one-minute period. They counted their own push-ups, and were encouraged to attempt to increase that number with the daily practice.

2. All the girls hung on both sides of the horizontal-ladder and attempted to do maximum numbers of pull-ups. After the girls had finished, all the boys did pull-ups. Everyone was encouraged to increase the number of pull-ups with the daily practices. Each child counted his own pull-ups.

3. Each child traveled by his hands on the rungs of the ladder, without skipping rungs, from one end of the ladder to the other. When he reached the other end of the ladder, he stopped and moved his legs in a bicycle pedaling motion for ten movements. If the child could not go all the way across the ladder, he was instructed to go as far as possible, keeping the ultimate goal of being able to complete this exercise in mind.

4. The last exercise was traveling by the hands one length of the ladder on the side of the ladder. The children were instructed to do this exercise slowly without swinging their bodies.

Analysis of Data

The Pearson product-moment method was used to determine the reliability of the test for grip strength. The correlation coefficient was found to be .860 for the first and second trials, indicating a high degree of reliability.

The mean scores made by both groups at the beginning and at the end of a three-month period are shown in Table 1. The subjects in the experimental group showed a considerable increase in all but the tests of grip strength. The percentage of increase in the mean scores is also shown in Table 1. The control group showed little difference between the mean scores made at the beginning and end of the three-month period.

TABLE 1

Summary of Basic Data

Test	Experimental Group			Control Group		
	Test 1 Mean Scores	Test 2 Mean Scores	Percent Mean Gain	Test 1 Mean Scores	Test 2 Mean Scores	Percent Mean Gain
1. Push-ups	6.21	10.54	69	7.97	8.55	7
2. Pull-ups	1.82	3.44	89	2.11	1.90	0
3. Grip Right	37.91	38.97	3	36.59	36.48	0
4. Grip Left	34.94	36.22	4	34.44	34.85	1
5. Pulling Strength	34.42	42.81	24	35.77	38.62	8
6. Pushing Strength	42.36	53.00	25	48.42	48.96	1

The mean difference in score between the first test and the second test may be found in Table 2. The experimental group showed greater gains in all the items than did the control group. The t test was used to determine the significance of the differences between the gains made by the experimental group and the gains made by the control group. The final differences between the groups were corrected by subtracting the mean gain of the control group from the mean gain of the experimental group in the formula for the significance of a difference in means of independent samples. The formula suggested by Lindquist (2) is as follows:

$$t = \frac{M_1 - M_2}{\sqrt{\left(\frac{N_1 \sigma_1^2 + N_2 \sigma_2^2}{N_1 + N_2 - 2}\right)\left(\frac{N_1 + N_2}{N_1 N_2}\right)}}$$

The t's and the levels of statistical significance for the six tests are shown in Table 2. The differences between the mean scores of the experimental group

and the mean scores of the control group for the push-up, chinning, the push strength and the pull strength tests were all significant at the one per cent level or better. The tests of grip strength of the right hand at the 30-per-cent level, and of the left hand at the 40-per-cent level were not statistically significant. The hand grips did not change since these muscle groups were not exercised actively. The mean differences of the control group may be attributed to normal growth and development and chance.

TABLE 2

Significance of Differences Between Mean Gains

Test	Control Group Mean Gain	Experimental Group Mean Gain	t	Level of Significance
1. Push-ups	.58	4.33	3.713	0.1%
2. Pull-ups	— .21	1.62	2.829	1.0%
3. Grip Right	— .11	1.06	1.017	30.0%
4. Grip Left	.41	1.28	.916	40.0%
5. Pulling Strength	2.85	8.39	4.999	0.1%
6. Pushing Strength	.54	10.64	7.625	0.1%

Summary and Conclusion

Two approximately equal groups of third-grade children, 66 subjects in all, were used to determine whether a specified amount of time spent in practice on the horizontal ladder would result in significant changes in strength. Six tests of strength were administered at the beginning and the end of a three-month period. The t ratios were computed to determine the significance of the obtained differences between the two groups. The experimental group made statistically significant gains in push-ups, pull-ups, pushing strength, and pulling strength. The hand grip gains were not statistically significant because those particular muscle groups were not exercised actively. The mean differences of the control group may be attributed to normal growth and development and chance.

The same amount of time for physical education was given to both groups so that the greater gains made by the experimental group can be attributed to the differences in programs. Ten minutes per day, five days a week, for a three-month period of special exercises using a horizontal ladder increased significantly the upper body strength of eight-, nine-, and ten-year-olds.

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(Submitted 5/25/54)

Selecting the Content of a Health Education Course on the Basis of the Needs of Students

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Abstract

In this study, the critical incident technique was used to determine the personal adjustment problems of 560 students who were taking a required Health Education course at Columbia College, Columbia University. These problems were then successfully used as the basis for the selection of the subject matter for this course.

THE STAFF TEACHING Health Education (officially called Personal Living) at Columbia College, Columbia University, felt that for effective learning the focus in the course should be upon the students' own needs. Of the many categories of needs, they selected one phase of the psycho-biological—that giving rise to personal adjustment problems about which the student himself feels live concern—as most pertinent to the Health Education course. The discovery of what these specific adjustment problems were, then, became of primary importance to the staff.

Basing health education courses on students' problems was nothing new. Oberteuffer (4), Rooks (7), and Cushman (2) had already developed techniques for discovering such problems. In each of these cases, however, the broad categories from which students were asked to select their needs were already chosen for them. Under a category heading of Respiration, doubtless the needs that are revealed will have to do with respiration. Such techniques were structured to the extent that they fixed the basic course materials. The Personal Living staff was looking for a technique which would allow the personal adjustment problems of the students to provide the basis for the broad areas of the course as well as for the details studied within these areas.

Others seeking to discover student problems had developed free-response techniques that asked, in essence, "What are your problems?" On applying these methods, the Personal Living staff found that, even after considerable student-instructor rapport had been established, the replies were largely superficial. One- or two-word statements such as "sex" and "study habits" were quite common, and a large number of "no problems" were received. Another limitation was that students did not know what their problems actually were. They recognized the intellectual or overt manifestation of the problem and wrote a good deal about it, but in most cases missed including what was revealed, after considerable counseling, to be the real source of the disturbance.

Method

Eventually, the writer had called to his attention a method that had enough structuring to avoid the pitfalls of free-response techniques and yet was unstructured enough to permit a free response. It was called the critical incident technique.

The critical requirement approach was developed initially during World War II in the Army Air Forces Aviation Psychology Program (1) and was later utilized in arriving at a procedure for evaluating Air Force officers (6). This technique consisted of getting a description of concrete incidents from officers who were in a position to observe such incidents, and who were intimately acquainted with the particulars of the job itself, which had been judged by them to be either effective or ineffective behavior in the performance of the job. Critical requirements were based on an analysis and classification of the behavior revealed in the description of these incidents. From these requirements a measuring instrument for officer evaluation was developed.

Procedure

It was assumed that, if students were able to record specific descriptions of incidents or problems that were disturbing to them, then from an analysis of these descriptions the Personal Living staff would be able to discover the personal adjustment problems of the students. This method would eliminate the camouflage of actual problems that occurred with the free-response techniques, and be specific enough to provide the staff good material for analysis. The task was to get a simple, direct form with a minimum of structuring, that would accomplish this end. The following form was developed:

As you know, a purpose of this course is to help you to live the fullest life of which you are capable.

Certain problems occasionally arise which adversely influence your personal living. If we know the nature of these problems, we can modify our class discussions in a way that may help you to develop insight into these problems, and thus work for their relief. In an effort to acquaint us with some of these problems please follow the directions given below:

1. Describe not more than three actual situations which have been disturbing to you. We would prefer descriptions of situations that have occurred within the last six months; however, you may include those which happened previous to this period but which for some reason remain vividly clear in your mind. Include full details of the situation, and of the nature of the consequent disturbance. Do not feel restricted to choosing situations which you believe are within the scope of Health Education; choose situations of any nature. Be as explicit as possible in your description, including all of the circumstances which you believe are relevant.
2. Use a separate sheet (attached) for each description.
3. Do not reveal your name. These descriptions will be kept rigorously confidential, but you may disguise any information that you feel might lead to your identification.

This form had been modified previously on the basis of a pilot study with 35 randomly-selected students taking Personal Living. A six-month limit was included to guard against inaccuracies in memory, and vagueness of detail.

This limit would also increase the probability that incidents described would still be disturbing, and more related to immediate problems than to those that had been resolved quite some time ago.

It was thought necessary to inform students that they could describe situations which they felt were outside of the scope of Health Education. In our pilot study this omission was discovered as a serious limitation. They asked again and again if it meant only things that had to do with Health Education.

Providing a single sheet for each description imposed a limit that made the descriptions more explicit; without this limit descriptions were less well organized, and more difficult to analyze. The descriptions were made anonymous in order to get the full flavor of the disturbance. In our pilot study, those who were requested to sign their names chose situations with much less depth than those who remained anonymous.

The students were not asked for an interpretation of the situations they described. It was found in the pilot study that requests for interpretations usually resulted in a generalized statement of a need which was probably not a valid interpretation of the intellectually-realized disturbance. It seemed easier for a student to describe intellectually disturbing behavior in certain situations than for him to identify the basic disturbance itself. A student's analysis of the situation he described seemed a little too much to expect.

During the academic year 1949-50, these forms were given to 560 students who were taking Personal Living. The forms were distributed by the instructors during regular class meetings. The forms were given out, in most cases, about the fourth week of a 16-week semester—as soon in the term as the forces which interfere with candid reporting had been relaxed, and a desirable amount of student-instructor rapport had been developed. The students were given an opportunity to ask questions about the forms. Questions were answered that in the opinion of the instructor did not structure the students' choice of situations. The overwhelming majority of students were college Freshmen.

Out of a possible 1,680 descriptions, 1,101 were turned in. Some students did not turn in any at all (participation was not compulsory), a few returned the blank forms, some filled in one description, and a reasonably large number described only two disturbing situations. A 65-per-cent return was judged excellent for this type of survey.

A general method of analysis was used which is called "content analysis" or "category formulation." This method consists of three steps by which a large number of descriptions of problems are successively reduced to a smaller number of descriptive headings or categories in a classification.

In the first of these three steps, each description (each was listed on a separate sheet) was analyzed to find the central or key behavior theme—what the problem actually was. A brief analysis of the problem was written at the top of the sheet. These analyses were "spot checked" by other members of the staff for accuracy of analysis.

Step two consisted of reading through all of these brief analyses and selecting general categories—short, general descriptions of a particular type problem—into which the specific problems were classified. This was a difficult job. The complexity of human life being what it is, the possible classifications were literally infinite. During this sorting, each problem was re-read and checked againt the broad category heading to which it was assigned. Because of the interplay of factors, there was much interrelationship between the problems, and it was sometimes difficult to make a definite assignment. Sometimes problems which seemed to belong under one category, when re-read in total, were different from others in that category.

Whenever this checking showed the need for another general category heading, one was added. The final result of this step was a group of general problem headings which very broadly described all the different problems revealed in all the descriptions. Its practical effect was the reduction of a large number of analyses of individual problems into a small group of general problem headings.

The third step in the method of analysis was establishing subheadings under the general problem headings. Specific problems which had been included under the same general heading, and which were closely related but not identical, were grouped under an appropriate subheading. Again the specific problems were re-read in total before they were assigned to the subheadings. The writer wanted to be especially sure that he was making the classification fit the problem rather than making the problem fit the classification. The results of the analysis and classifications are given in Table 1.

TABLE 1

The Personal Adjustment Problems of the Students

(Listed in order of percentage of the total of 1,101 descriptions)

Percentage	Category
25	Scholastic Situations
20	Sexual Adjustment
13	Emotional Adjustment
12	Vocational Planning
10	Home Relationships
9	Social Adjustment
5	Religion
3	Economic Adjustment
3	Motivation and Goals
1	Personal Health Habits

Findings

An elaboration of the categories in Table 1 follows:

Scholastic Situations—Poor study habits and inefficient reading techniques; inability to concentrate on studies; lack of balance between studies and extra-curricular life; feelings of academic inferiority; difference between academic

standards of high school and college; inability to get grades necessary for entrance to professional school; fear of examinations; unfavorable conditions for study in dormitories, libraries, and home; dislike of teachers.

It should be recognized, however, that while there is much interrelation among the problems in all of the categories, disturbances in other areas are more likely to be reflected in study habits than in any other broad category. Studies, at the college level, are the barometer of personal adjustment. Inability to concentrate on studies was one of the difficulties most frequently mentioned and serves as an illustration of this point. If no reasons for the inability were apparent from the description, analysis necessarily assigned the problem to Scholastic Situations while in reality there were doubtless other reasons which created or aggravated this inability. The critical incident technique reduced such occurrences but did not eliminate them completely. This explanation considered, there are still a tremendous number of problems in this area being experienced by the students.

Sexual Adjustment—Concern over dating, courtship, and petting; conflict between sexual practices and religious and moral teachings; concern over masturbation, pre-marital sex relations, and other sex behavior.

The big question, theoretical or actual, was whether or not to have pre-marital sex relations. Apart from writing descriptions of problems, many came right out and asked for information in regard to certain sex behaviors.

Emotional Adjustment—Anxiety; inability to make decisions; lack of self-confidence; feelings of cowardice; disturbed by unsettled condition of world affairs; extreme sensitiveness; day dreaming; speech defects; lack of emotional control.

Lack of self-confidence was what most students felt most strongly and about which they wanted something to be done. Many mentioned that they were uncomfortable when called upon to recite in classes.

Vocational Planning—Vocational indecision; conflict between own vocational goals and those prescribed by parents; fear of non-admittance to professional school; lack of ability in subjects required for desired vocational preparation; security vs. interest in profession; summer and part-time employment; fear of not being prepared at graduation for any vocation.

Being disturbed by having no vocational goal was the most common problem. Some students complained very strongly of parents who would not let them study for the vocation they had chosen for themselves. Many of the students wanted to know how they could get help with making a vocational choice.

Home Relationships—Incompatibility of members of the family; need for, or fear of, increasing independence from parental control; death of a parent; parental pressure for better grades; sibling jealousy.

Much resentment against domination by parents was indicated, and many students felt that their parents were still treating them like children. Some resented the difficulties of living up to a reputation established by an older sibling.

Social Adjustment—Inability to make suitable friends; unsuccessful attempts to achieve status; prejudice; feeling out of place at parties; difficulties with roommates; inability to dance; lack of popularity with girls; self-consciousness in the presence of girls.

Feeling out of place, or inferior, in social groups, especially in the presence of the opposite sex, was the most frequently mentioned problem. Some students added to

their descriptions of disturbing situations that they would like some help with meeting friends of both sexes.

Religion—Conflict between views of religion and materials studied in courses; doubt concerning existence and nature of God; religious convictions that are ridiculed by others; lack of knowledge of own religion; religious prejudice; inter-faith dating and marriage; conflict between own religious beliefs and those imposed by parents.

There were several indications of strong feelings of anxiety and distress in regard to religious life. Some students admitted that they were "all mixed up." The most frequent complaint was against parents who forced the student into religious practices against his will.

Economic Adjustment—Fear of having to leave college for financial reasons; interference of part-time work with studies; lack of money for dates and recreation; resentment of, or worry over, financial dependence on parents.

The big worry in this area was fear of having to drop out of college because of inability to pay tuition. Students resented parents who gave them money in driblets instead of putting them on a regular allowance.

Motivation and Goals—Lack of a life goal; lack of interest in college environment; uncertainty as to value and desirability of a college education.

Most expressed uncertainty as to the desirability of their remaining in college. Others felt that they were drifting; their lives seemed to have no purpose.

Personal Health Habits—Lack of knowledge concerning nutrition, fatigue, sleep and relaxation; acne; smoking; lack of physical energy; inability to regulate weight; physical handicaps.

Concern over smoking was mentioned more frequently than any of the others.

The depth of the descriptions was unexpected. Students described incidents which they admitted were very disturbing to them. For some, describing the incidents was a therapeutic device in itself—they seemed to clarify and resolve their problems in the process of writing about them. Others openly solicited help with their difficulties.

When these adjustment problems were introduced into class discussion and used to select the areas included in the course, it was evident that Personal Living was coming closer to the needs of the students than it ever had before. The response of the students was gratifying. Class discussions became much more meaningful. While some of these broad areas were in the course previous to the survey, they could now be discussed to greater depth. They were better defined. They were actually the concern of the students themselves. Instructors now had evidence that such problems did not exist largely in the minds of adults, and they applied themselves with new conviction to the teaching situation.

Recommended Changes

Certain results of this survey suggested modifications for future surveys. The wording of the form soliciting the descriptions seemed to promise too much in view of the practical limitations within which the course operates. Some students thought that the course would definitely be modified to deal

with their individual problems. Such modification was not possible in all cases, and these students were disappointed. Others thought that since they had written about their problems the course was obligated to solve them. To avoid "broken promises" in the future, the form will be modified and toned down. Descriptions will be solicited on the basis of "discussing in the course things that are interesting to you," rather than "help you to develop insight into these problems, and thus work for their relief."

It is interesting to note that, after analyzing 600 descriptions, it was seldom that any new situations were described. The same situations were repeated, with little change in detail. Occasionally, of course, some completely new type of incident was described, but these were usually singular and not significant in the ultimate analysis. In quite a few cases, the third descriptions were forced, cursory, poorly organized, and difficult to analyze. Students had apparently expressed most of their strong feelings in the first two descriptions.

With these facts in mind, it is recommended that a similar survey undertaken in the future with between 500 and 600 students should ask for only two descriptions of incidents from each student. This procedure should provide enough descriptions for analysis, make analysis a less difficult and time-consuming task, be a more reasonable demand to make of students, and tend to equalize the contributions of individual students to the ultimate focal points of course experiences.

Conclusion

The survey achieved its purpose. The personal adjustment problems of the students in Personal Living had been discovered, and are being used successfully as focal points for learning experiences in the course.

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(Submitted 7/1/54)

Relation of Charging Time to Blocking Performance in Football

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Abstract

Blocking performance was rated from game pictures by three experienced judges using methods that correlated r = .92. Objectivity coefficients ranged from r = .88 to .99. Charging time (measured in the laboratory) had a reliability of .92, but failed to correlate significantly with the ratings (r = −.28 to .34) or with game time r = −.18). A variance analysis showed no relation between position played and charging time (F = .46). Accuracy of "timing" movement is probably more important than speed of response in charging.

ONE OF THE FEW published studies concerned with the offensive charge in football was conducted some 20 years ago by Miles (12). Using 87 members of the Stanford University football squad as subjects, Miles obtained seven measures of their charging time, which he referred to as "reaction time." The tests were made of the subjects responding to an auditory stimulus by lunging forward from a crouch stance against rods placed approximately four inches in front of their heads. The movement of the rods caused golf balls to drop on a moving drum. The average charging time of the subjects was 389 milliseconds, with first team members averaging 353. The backs as a group were the fastest, with an average time of 360 milliseconds as compared to 377 for the ends, 383 for the guards, 395 for the tackles, and 444 for the centers. No statistical evaluation of the significance of differences by position was presented. He reported there was no significant correlation between charging time and weight or height. The correlation with playing skill—the opinion of the coaches in terms of efficiency—was quite low.

Keller (9), in testing a large group of subjects, found that athletes as a group scored significantly better than non-athletes in quickness of bodily movements. He also suggested that there was a definite trend and a real relationship between bodily movement and success in athletics, success being measured in terms of letters won, time played, "listed on the squad," or a rating by the coach or physical education instructor.

Elbel and associates (5), in a recent study, measured the speed of charge and the horizontal force exerted in the charge in 45 varsity football players. They reported no relationship between the speed of the charge and the force exerted.

[1]From the Research Laboratories of the Department of Physical Education. The writer is indebted to Dr. Franklin M. Henry for advice and criticism.

Examples of the few studies intended to establish objectivity in rating performance are those of Brady (2) concerned with volleyball, Elbel and Allen (4) in relation to basketball, and Keenan (8) on objective methods of measuring ability in horseback riding. There is a lack of published material dealing with the rating of performance in football, although the widespread use of motion pictures in modern-day football is a definite aid to rating performance which many other activities do not enjoy. The development of an appropriate method of rating was required for this study.

Coaching Opinions. Examples of the relative importance attached to the fast charge in football may be seen in the amount of time devoted to practicing this action. The University of California squad spends approximately 25 per cent of the one-and-one-half-hour practice period each day working on the charge, either in position groups or team groups. Munn (13), of Michigan State, considers that the effectiveness of his offense is based on a fast "take-off." All his drills in group work are designed to improve the take-off and reaction time of his linemen. Through constant repetition and practice of this action, he hopes to develop what he terms an automatic explosiveness. Tatum (16), coach of the 1954 National Champion University of Maryland team, considers the charge the most important advantage of offensive football.

The one fundamental action engaged in by a large percentage of football players at all times during a game is blocking, whether it be on the line of scrimmage or downfield in the opponents' territory. Furthermore, effective blocking is considered the foundation of all offensive football as evidenced by the opinions of such great students and teachers of the game as Zuppke (18), Rockne (14), Bierman (1), Crisler (3), Waldorf (17), Smith (15), and Leahy (11).

It would seem reasonable then that a rating of the blocking performance of individuals would be an acceptable measure of one of the important aspects of football skill, and the relation of charging time to this rating would substantiate or deny the importance attached to speed in this action.

Purpose of the Study

The purpose of this study is to determine the relation of individual differences in performance of a fundamental action in football, such as blocking, with individual differences in the response time of a typical neuro-motor action, such as charging, that is considered basic and important in football. Incidental to the study is the development of a method for rating blocking performance.

Method and Procedure

Subjects. Thirty-one subjects, all members of the University of California football team, were tested for average charging time (response time). Twelve of the subjects played sufficient time on offense to be rated by three judges on blocking performance in five games by use of movies.

Response time of the charge was measured using an electric chronoscope read to 0.01 second. The fore-period was varied from one to three seconds between a preparatory signal and the stimulus. Fore-periods of one-half and four seconds were used as "catch" tests. Each subject had 20 trials and two "catch" trials, following five practice trials. The "catch" trials were interspersed with the final measurements.

Administration of the stimulus activated the chronoscope which ran until the subject struck a target attached to an extension from a hinged type circuit breaker. The target then swung out of the way, permitting the subject to lunge on through without restriction (see Figure 1). A mattress was placed in front of the target to break the fall of the subject.

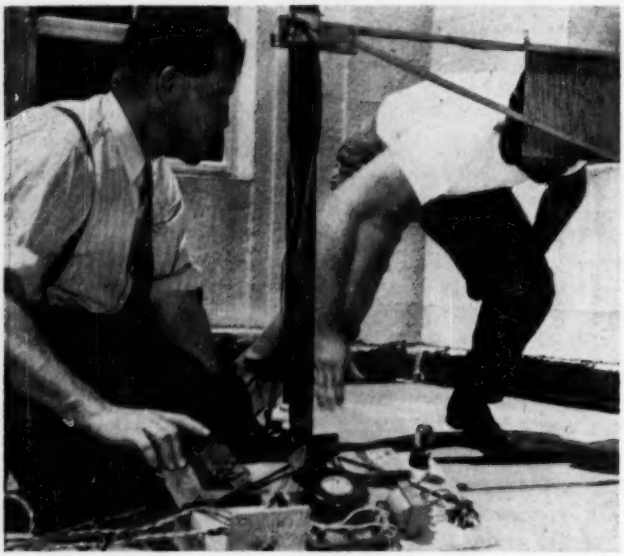

FIGURE 1. The Apparatus Used To Measure the Speed of Charge.

Since testing was conducted indoors, a rubber mat and tennis shoes were used to provide a better surface and footing. A wooden starting block was also employed to simulate the anchorage afforded by football cleats in the turf in a normal, outdoor situation. A thermostatically controlled room away from noise was used for testing. Each subject reported to the testing room at a prearranged time attired in sweat-suit, tennis shoes, and a leather helmet.

Instructions. The subjects were oriented in the testing and, after a controlled warm-up period, were given five practice trials. The subjects were told to crouch in a preparatory stance—feet in position, half crouch, with the forearms resting on the thighs—and at the warning signal of "ready *set*"

(with a rising inflection on the set) the subjects assumed a three point stance. The subject responded to the buzzer signal by charging through the target, which was to be struck with the head. The distance of the target from the subject's head was held constant at 12 inches, which corresponds to the length of a football, and represented the neutral zone between the offense and defense.

· *Rating of Blocking Performance.*[2] A rating scale or score card method was developed as an objective means for rating performance in the shoulder block. It is not possible to measure blocking effectiveness in time or distance units as can be done for some other skills.

Development of the rating scale followed analysis of blocking performance by the University of California coaching staff, including the author. The scale was constructed on the following premise: The purpose of the shoulder block in football is to drive the opponent out of position in order to create a running lane for the ball carrier or to prevent an opponent from moving into the ball carrier's path, by getting and keeping the body between the opponent and the play.

The *Criteria* rating was a 16-point composite rating scale which divided the shoulder block into four component parts: *Approach, Body Position, Jolt,* and *Follow Through.* Each component part in turn was broken down into four items. A written criterion for acceptable performance in each of these items appeared on the rating card, and the subjects were scored pass or fail on each. The highest possible score was therefore 16 points. The items of the rating scale were as follows:

(1) *Approach*
- a. Get-off
- b. Timing
- c. Angle
- d. Body control

(2) *Body Position*
- a. Stance
- b. Mechanics while moving
- c. Striking distance
- d. Launching distance

(3) *Jolt*
- a. Uncoil
- b. Point of contact
- c. Force of contact
- d. Control

(4) *Follow Through*
- a. Maintain contact
- b. Leg drive
- c. Driving base
- d. Control

Another type of rating, designated *Efficiency,* was based on the degree of success in completion of each blocking assignment. This evaluated, in percentage units, the degree of success in achieving the objective of the shoulder block, regardless of technique used. This rating was independent of the *Criteria* items. Possible scores in the *Efficiency* rating could range from 0 to 100.

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[2]Appreciation is expressed to Dr. F. W. Cozens for advice during the development of the rating methods.

Copies of the rating instructions and scales will be furnished upon request to the writer. (Present address: Division of Physical Education, Chico State College, Chico, California).

The official game movies of the University of California were used as the basic data. Five games were chosen on the basis of quality and completeness of the film as well as being representative of the performance of the 1949 team. The three raters were instructed concerning the criteria and techniques to be used in rating. These raters were selected because they had experience in coaching football and in teaching the shoulder block particularly, and also had an understanding of the system of play that served as the rating media.

The ratings were made during a period of three weeks. Two consecutive rating sessions of one hour's duration and a 20-minute rest period between sessions were completed each day. Each rater was presented with a looseleaf pad containing a scorecard for each play to be viewed, and was instructed to rate each player in the order in which a number preceded the position. This was done in order to prevent the raters from rating the same player at the same time. The movie sequence of each play was re-run five times for each player as per each item and also for effectiveness. In the event the rater wanted to view the play again, he could signal the operator. Fourteen subjects, representing the offensive linemen, were rated in 626 performances.

Experimental Results and Discussion

Response Time. For 31 subjects, the average of 20 trials for each individual ranged from 321 to 507, with a mean of 386 and a standard deviation of 30 milliseconds. The correlation between the combined first and third sets of five trials and the second and fourth sets of five trials was $r = 0.942$. Using the Spearman-Brown correction, which is mandatory and justified, the reliability coefficient becomes $r = 0.970$. This is an indication that there is a rather high reliability of the measure of response time.

Table 1 gives the average charging speed by players position. On the average, the guards were fastest and the tackles and ends were slowest. The t ratio for the difference between these extreme groups is only 0.88, so there is no evidence of any significant difference. A variance analysis of charging speed by player's position yields a variance ratio of $F = 0.459$, which again indicates no statistically significant variation in average charging time by position. (Tackles and ends were combined, inasmuch as their functon is very similar, particularly for the group studied.)

Comparison of charging times obtained in this study (Table 1), with those by Miles (12) shows disagreement with his report that the backs were faster than the linemen. This difference in the two findings probably indicates the trend in modern football coaching philosophy which now tends to emphasize unit or team speed as compared to speed in certain positions such as the backfield. Since Miles used a different technique, moving shorter distances, it is not possible to compare average response times in the two studies.

Criteria and Efficiency Ratings. The objectivity of the ratings by the three judges was tested by determining the inter-judge correlations.

TABLE 1

Summary of Average RT (in milliseconds) according to Player's Position and Task.

16 Offensive personnel	385 ms	10 First Team Offensive	385 ms
15 Defensive personnel	388 ms	9 First Team Defense	386 ms
6 Centers	389 ms	8 Guards	375 ms
9 Tackles and Ends	395 ms	8 Backs	386 ms
23 Linemen	386 ms		

In Table 2 it can be seen that the inter-judge correlations are rather high ($r = 0.881$ to $r = 0.994$). The coefficient of correlation between the C rating and E rating is $r = 0.921$, indicating a considerable amount of internal validity. It is also an indication that the reliability of the rating is satisfactory.

TABLE 2

Summary of Correlation Coefficients (r) obtained from the Data

Ratings	Criteria Rating	Efficiency Rating
Rater A with Rater B	$r = 0.881$	$r = 0.918$
Rater A with Rater C	$r = 0.965$	$r = 0.960$
Rater B with Rater C	$r = 0.963$	$r = 0.994$
Average C rating with average E rating		$r = 0.921$
Average C rating with Game Time		$r = -0.131$
Average E rating with Game Time		$r = -0.237$
Average Response Time of the first and third set of five trials with the second and fourth		$r = 0.942$
Speed of Response with Criteria Rating		$r = -0.342$
Speed of Response with Efficiency Rating		$r = -0.283$
Speed of Response with Game Time		$r = -0.182$

The correlation coefficients between the C rating and E rating in relation to Game Time ($r = -0.131$ and $r = -0.237$) indicate that there is no statistically significant relationship between these measures. Game Time, in terms of total minutes played during the season, may or may not have some implications as a criterion of football success, but it evidently samples a different type of success than either the C rating or the E rating. Furthermore, Game Time is not significantly correlated with speed of the charge ($r = -0.182$).

Response Time and Ratings. Correlation of the average speed of response of 12 subjects with their average *C* rating gives a correlation coefficient of $r = -0.342$, which indicates no statistically significant relationship. The correlation between E rating and speed of response is $r = -0.283$, which means that there is no statistically significant relationship between these two measures either.

In interpreting the factual results of this study it must be remembered that the football players studied constituted a relatively homogeneous group. The above correlations would have been higher, if it be assumed that there is really a genuine relationship between the variables being compared. On the other hand, there was sufficient heterogeneity in the group to give quite high intercorrelations between the two evaluations of blocking ability, and also the reliability of the measured speed of response is quite high. Therefore, there seems to be no evidence to justify the belief that the lack of relationship is due to the homogeneity of the group. Pronounced individual differences in the abilities tested were certainly present in the sample.

While most coaches expect a positive relationship between speed of response and sports performance, this is not clearly established. Lacy (10), for example, found that inexperienced subjects increased the time spent on the blocks as they improved their starts in sprint running. Ghiselli and Brown (6, *p. 388*) found that streetcar motormen with fast reaction time tended to have somewhat more accidents than those with slow reactions. As previously mentioned, Elbel and associates (5) found no relationship between speed of charge and horizontal force exerted. In general, the positive relations that have been reported show only that certain groups of athletes are *on the average* faster in their reactions than certain other groups, or faster than non-athletes (9). The possible advantage of a fast reaction is a complicated matter. For example, it has been found that there is no correlation between *reaction time* and *movement time* (7).

In the writer's opinion, on the basis of observations both as a player and a coach, quickness of response is sometimes confused with "timing," i.e. the coordination of movement with a prearranged stimulus which can be anticipated. For example, in football the timing of the charge to occur simultaneously with the signal is the important thing. A preparatory signal is therefore given in advance of the charging signal, with a constant interval of time that is usually counted out to give a cadence. Only the offensive team is aware of which count will be the charging signal, and only they can anticipate it and time their charge accordingly. On the other hand, in reaction-time experiments, considerable pains are taken to provide a *variable* fore-period interval in order to prevent anticipation of the signal. This ability to time the charge in relation to the stimulus is different than quickness of response, and our confusion of these two may be a reason why coaches expect a positive correlation between quickness of reaction and good performance of a fundamental action such as blocking.

In addition, the power of the charge must be considered in relation to blocking performance. It may be these two items, timing and power, are positively correlated with blocking performance. These are possibilities which might be worth considering in future research. Of particular interest would be the relation of power exerted, as measured by Elbel and associates (5), to blocking performance as determined in this study.

Summary and Conclusions

Thirty-one subjects, all members of the University of California football team, were tested as to their response time in terms of executing a charge over a distance of 12 inches. Twenty trials were made, following a warm-up period and five practice trials. The mean time of the group was 386 milliseconds, with the guards as a group having a mean time of 375 as compared to 386 for the backs, 389 for the centers, 392 for the tackles and 398 for the ends. The mean time for the linemen was 386 milliseconds.

Fourteen subjects, 12 of whom had previously been tested as to charging time, were rated through the use of five game movies as to their individual blocking performance. Ratings were on the basis of specific criteria and, in addition, an over-all estimate of efficiency.

Reliability of the charging time test was determined by correlation of the first and third set of five tests with the second and fourth set of five tests. The reliability coefficient obtained was $r = 0.970$ (corrected).

A reliable method for rating blocking ability was developed. Objectivity of the ratings, determined by correlation of the average ratings of the three judges, ranged from $r = 0.881$ to $r = 0.994$.

A variance analysis of charging speed by playing position yielded a variance ratio of $F = 0.459$, which indicates no significant relationship.

Individual charging speed yielded correlation coefficients of $r = -0.283$ and $r = -0.342$ with the two types of ratings, which indicates no statistically significant relationship.

The statistical analysis of the data leads to the following conclusions:

1. Within a group of experienced university football players, there are pronounced individual differenes in speed of charging, and also in blocking performance. However, there is no statistically significant correlation between these two types of individual differences.

2. An essentially zero relationship exists between total time played in games and speed of response or blocking efficiency or blocking ability.

3. There is no appreciable difference in speed of response in relation to position played.

Consideration of the elements involved in successful blocking suggests that "timing" of the response, rather than speed of response, is the important factor.

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(Submitted 8/3/54)

Repeated Volleys Tests for Women's Volleyball

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Abstract

One hundred and ten Freshman and Sophomore university women students were given repeated volleys tests in volleyball at restraining lines 3, 5, and 7 ft. from the wall, as had similarly been done at the 3-ft. distance. It was found in this study that the test was reliable at the 5- and 7-ft. lines as well as at the 3-ft. distance. The test at the 7-ft. restraining line was found to have greater validity with these subjects than at the 3-ft. line. It was also found that the estimated validity for three trials at the 7-ft. line was greater than the validity for the sum of the scores at the 3-, 5-, and 7-ft. lines.

FOR SEVERAL YEARS the writers have observed women college students during the administration of the repeated volleys test as described in the Russell-Lange study (9). It was noted that the ball was volleyed or batted against the wall more frequently than it was set up and then volleyed. Since one of the objectives of the girls game is to control the ball and then pass it successfully to a teammate, it seemed desirable to administer a test which would encourage the student to use this set-up skill. By moving the restraining line back from the wall to 5 ft. or 7 ft. it was found that the players then used more set-ups and involved more body movement than at the 3-ft. restraining line.

It also was noted that many of the taller players had less difficulty than shorter players in executing the skill from the 3-ft line. Since perhaps the short distance made their higher scores the result of their height rather than of their volleyball playing ability, the 5-ft. and 7-ft. restraining lines again seemed to be advantageous. All players set up the ball more frequently at these distances, and all players had some difficulty, especially at the 7-ft. line.

The Problem

Since the Russell-Lange 3-ft. repeated volleys test has been established as reliable and valid, the purpose of this study was to investigate the reliability and validity of the same test when performed 3, 5, and 7 ft. from the wall. One hundred and ten women students at the University of Maryland participated in the study; women majoring in physical education as well as general education students from volleyball classes were tested during the academic year 1953-54.

Review of Related Literature

A review of the research concerning volleyball skill tests revealed frequent use of repeated volleys tests in order to measure over-all game playing ability.

French and Cooper (4) worked with a repeated volleys test using a restraining line 3 ft. from the wall. Ten trials were given, each trial 15 sec. in length. The score was the sum of the five best trials. Four judges rated the players, but no explanation was given about how the ratings were done. The correlation of the volleys test with the ratings was .72 for 47 girls in grades ten through 12 and .43 for 180 girls in ninth and tenth grades.

The volleys test as studied by Bassett, Glassow and Locke (1) used a starting line 6 ft. from the wall, but thereafter the player could stand anywhere. Three 30-sec. trials were given to 109 college women. The reliability of the volleys test was .84 for the best trial out of three and .89 using the sum of the three trials. The validity of the volleys test was .51, using instructors' ratings. It was recommended that playing ability be rated separately from serving ability. This recommendation was followed in the present study.

The former studies dealt with high school and college girls. Russell and Lange (9) worked with achievement tests for junior high school girls. They selected the repeated volleys test and the serve test from the French and Cooper (4) battery. The volleys test was modified to involve three trials of 30 sec. each at the 3-ft. restraining line. The reliability computed on two trials five days apart was .87 for the best of three trials and .90 for the sum of three trials. Seven judges used a four-point scale from excellent to poor in the validity studies, rating 66 players during tournament play. The validity correlations ranged from .61 to .67, but when corrected for attenuation and random errors were .63 to .80.

In 1943 Crogen (3) reported a repeated volleys test for high school girls. The player started behind a 6-ft. restraining line but could move anywhere thereafter. The time factor was excluded. The reliabilities, with 129 girls, ranged from .48 to .52 for ten hits. The same girls were retested with 20 hits instead of ten; the reliability then went up to .83. Instead of basing the validity of the test on judges' ratings, as cited in other studies (1, 4, 9), Crogen based the validity on the ability to play volleyball in a competitive situation. It was found that the teams made up of players with higher test scores won more games than those with lower test scores, thus indicating the validity of the test.

Brady's study (2) on the repeated volleys test used 522 college men and 15 YMCA expert players. It was carried out along the same lines as the others reported, but with no floor restrictions and a one-minute time limit. The validity, based on the combined ratings of four judges, was .86 and the relibility was .925.

Fulton (5) found that teammate status was as closely related to teacher judgment of skill in volleyball as were the scores on the French and Cooper (4) repeated volleys test. The volleys test scores correlated .71 with ratings of skill made by the teachers and .54 with the scores of teammate status. Scores of teammate status correlated .71 with the rating of skill by the teachers.

Lamp (7) investigated the volleyball playing ability of 806 junior high school boys and girls in relation to various physiological and growth factors. The French and Cooper (4) volleying test was among the tests selected; using 90 girls, the reliability was found to be .64. By comparing the test scores of all other girls with girls selected to play on intramural and intraschool teams, it was found that the better players made better scores on all of the tests. The correlations of the volleying test scores with growth factors for the girls were: age, .96; height, .47; weight, .36. The factor of height for both boys and girls showed more relationship to the volleying test than to any of the other tests. This finding agrees with the hypothesis expressed in the beginning of the present study.

Procedure

The Russell and Lange repeated volleys test used three trials of 30 sec. each, with a restraining line 3 ft. from the wall. In this study the three trials were retained, but only one was taken at the 3-ft. line; the other two were at 5-ft. and 7-ft. lines, respectively. The following is a full description of the tests as used in this study.

Equipment: Well-inflated balls, unobstructed wall space 10 ft. long and 15 ft. high, stop watch. A line 10 ft. long is marked on the wall, 7½ ft. from the floor and parallel to the floor. Three other lines are marked on the floor, 10 ft. long, parallel to the wall, and 3, 5, and 7 ft., respectively, from the wall.

Test: Player stands behind the 3-ft. line and tosses the ball to the wall with an underhand toss. When it returns, she volleys it repeatedly against the wall above the net line, for 30 sec. The ball may be set up as many times as desired or necessary to maintain control; it may be caught and re-started with a toss as at the beginning. If the ball gets out of control, it must be recovered by the player and brought back to the 3-ft. line to be started again with a toss. The second trial is exactly like the first, except that the player must remain behind the 5-ft. line; in the third trial the player uses the 7-ft. line.

Scoring: The score for each trial is the number of times the ball is clearly batted (not tossed or held) from behind the proper line to the wall, on or above the net line there. One person in each group counts the volleyed hits on or above the line; another counts the times the player steps over the restraining line (telling her as she does so). The latter is subtracted from the former to obtain the score for the trial. The score for the entire test is the sum of those for the three trials.

In order to study the reliability of the tests, 69 Freshman and Sophomore University of Maryland general education students took the tests as described above during the sixth week of an eight-week volleyball unit. One week later, at the same time of day, with the same administrators, and under conditions as identical as possible, the tests were repeated. Only one volleyball class meeting was held between the two testing periods, during which time the students played a 16-min. game and took service tests.

In order to study the validity of these tests, four classes in volleyball were used, three of which were composed of 24-38 Freshman and Sophomore general education students and one of 25 Freshman majors in physical education. These students took the volleys tests one day and at the next class meeting

were rated subjectively in a game situation by three experienced judges during the seventh week of a seven- or eight-week volleyball unit.

The rating form (a copy of which appears in the Appendix) was developed for this study, using some of the principles used in rating women officials. It was first tried out by the judges on a volunteer group of major students of average playing ability, and was revised as a result of that trial. Serving was omitted from the rating since the service test was not being studied, and since all other items in the rating involved activities related to volleying.

The players in each class were arbitrarily divided into teams by the instructor in charge, who attempted to equate the groups according to height and estimated volleyball ability. Each team of eight girls was rated during an eight-minute period, with all judges rating simultaneously, standing on chairs at the rear of the team being rated. The players wore pinnies with large numbers from one to eight on front and back, and were identified by number only during game play. They played a rotation game throughout. Two of the three judges were not acquainted with the students. The recording and scoring methods are explained on the rating form in the Appendix.

Results

The reliabilities were computed by the Pearson product-moment method, using the 69 cases described above. Scores were available for one trial at each distance, and the Spearman-Brown Prophecy Formula, as quoted in Scott and French (10), was used to predict the reliability for three trials at each distance. Table 1 shows the reliabilities found and the predicted reliabilities for three trials at each distance.

TABLE 1

Reliabilities of Repeated Volleys Tests

Distance	Obtained r	Predicted r for three trials
3-ft. line	.81	.93
5-ft. line	.81	.93
7-ft. line	.83	.94

To compare with the ratings of the judges, each judge's scores were correlated with each of the others' scores. These results were: Judge 1 with Judge 2, .88; Judge 1 with Judge 3, .81; Judge 2 with Judge 3, .86. Since these correlations were sufficiently high, the total of the judges' scores were used for validity computations, rather than averaging them.

A rough indication of the validity of the ratings and the tests was shown by the fact that the average rating of the major students and their average scores on all three tests were higher than those for the other groups of students. It was the general opinion of the judges that the major students played better volleyball than did the other classes.

The validity coefficients, found by correlating the total judges' scores with the test scores, are shown in Table 2. A separate validity coefficient was computed for each distance, and also validities for the scores at the 5- and 7-ft. lines together, and for the sum of all three trials. Lindquist (8) quotes a formula for estimating the validity of a test n times as long as a given test; estimated $r = \dfrac{\text{obtained } r}{\sqrt{\frac{1-r}{n} + r}}$ where r in the denominator stands for the reliability of the short form. This formula was used for the estimated r for three trials in Table 2.

TABLE 2

Validities of Repeated Volleys Tests

Distance	Obtained r	Estimated r for three trials
3-ft. line	.64	.68
5-ft. line	.67	.72
7-ft. line	.75	.79
5-ft. plus 7-ft. scores	.77	
3-ft. plus 5-ft. plus 7-ft. scores	.69	

In order to test the significance of the difference between the 3-ft. and 7-ft. validity coefficients, it was first necessary to correlate the scores at the 3-ft. line with those at the 7-ft. line. This correlation coefficient was found to be .62. Then formulas from Guilford (6) were utilized to obtain the ratio of the difference between the obtained validities and the standard error of that difference. This ratio was found to be 1.96, which indicates significance at the 5-percent level of confidence. Using the estimated validities for three trials at each line, the ratio was 2.16, also significant at the 5-percent level. Upon comparing the validity of the sum of the trials at the 3-, 5-, and 7-ft. lines (.69) with the estimated validity for three trials at the 7-ft. line (.79), the ratio was 2.04, with a 5-percent level of significance. Guilford (6), in a chart on p. 209, calls the 5-percent level "significant," while the 2-percent and 1-percent levels are "very signicant."

Conclusions and Recommendations

With the subjects used in this study, it was found that the reliability of the repeated volleys test was almost the same at the 3-, 5-, and 7-ft. lines. The predicted reliabilities for three trials were .93 or .94, which was somewhat higher than any of the reliabilities quoted by the previous studies using girls and women as subjects.

The validities found in this study were also higher than most of those quoted in previous studies with girls and women. Both the obtained validity for one trial and the estimated validity for three trials at the 7-ft. line were

significantly greater than those at the 3-ft. line, respectively. The estimated validity for three trials at the 7-ft. line was also significantly greater than the validity for the sum of the scores at the 3-, 5-, and 7-ft. lines.

On the basis of these findings, and from watching many students perform these tests, the authors intend to revise their test to include three trials at the 7-ft. line and eliminate the 3- and 5-ft. distances. It is recommended that other colleges and high schools try this out and study the validity of this revision in their situations. It is also recommended that a study be made of the relationship between the height of players and their scores on the repeated volleys test at the 3-ft. line and at the 7-ft. line. Lamp (7) found some relationship between height and volleys scores, but further study is needed to substantiate these findings.

If time permits only two trials, the data presented in this study might suggest that these be at the 7-ft. line, or one at 5 ft. and one at 7 ft. It was found that the estimated validity for two trials at the 7-ft. line was .78, as compared with the validity of .77 using the scores at the 5-ft. and 7-ft. lines. Further studies should be made, using two or three trials at all three lines, to substantiate the findings presented in this study.

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(Submitted 7/27/54)

Evaluation of Men's Physical Education Service Programs in Higher Education in New York State[1]

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Abstract

The purpose of the study was to evaluate the service programs of physical education for men in the colleges of New York State. Dual standards (optimal and essential) were developed to serve as bases for evaluating the component parts of the overall program. A representative sampling of fourteen institutions was obtained and these institutions were studied extensively. It was found that the percentages of institutions of higher education in New York State requiring physical education for graduation, and giving credit for such courses, was much lower than has been found to exist in similar institutions throughout the United States,

THERE HAVE BEEN many studies, researches, and articles devoted to the various phases of physical education but the required or service program of physical education has remained more or less an undeveloped area. It was felt that there was a positive need for a study in which the needs of college students were determined, principles based on these needs established, standards substantiated and verified by authorities, and evaluations made of the service programs of physical education in light of these criteria.

The Problem

The purpose of this study was to construct an instrument for evaluating the men's required or service programs of physical education in the universities, liberal arts and teachers colleges of New York State. Evaluative criteria were derived from a study of the needs of college students and broad administrative principles of physical education. Dual standards (optimal and essential) were developed to serve as bases for evaluating the component parts of the over-all physical education programs. The problem could be solved if the answers to the following questions could be ascertained.

1. What are the needs of college students which should be met through the physical education service programs?
2. What are the principles based on these needs that should govern the operation of the physical education program?
3. What standards may be established and validated for evaluating the physical education service programs?

[1]This study was made in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the School of Education of New York University, 1953.

4. What evidence is necessary to show the present status of the service programs in physical education for men in the colleges of New York State?
5. What constitutes the evaluation of the present physical education program in light of the standards developed in the study?
6. As a result of the evaluations, what conclusions may be drawn from critical analyses of the data obtained?

Procedure

The determination of needs of college students which should be met, wholly or in part, by the physical education service program involved the collection of data from statements of authorities and a survey of authoritative literature. The works of such authorities as: Bogardus (1), Brace (2), Cobb (3), Crow and Crow (4), Cureton (5, 6), Deaver (7), Horne (8), Hughes (9), Jennings (10), Jones (11), McCloy (15), McCormick (16), McCormick (17), McCurdy and Larson (18), Moreno (19), Nash (20), National Conference on Higher Education (21), Nixon and Cozens (23), Schneider and Karpovich (25), Sharman (26, 27), Soronson (28), Steinhaus (29, 30), U. S. Office of Education (31), Voltner and Esslinger (32), Williams (33), Williams and Brownell (34), Young (35), and Zeleny (36) formed a framework for determining the needs of students. The five major needs were found to be: organic development, neuro-muscular skills, knowledge, social adjustment, and leadership. The needs thus established served as a guide in forming judgments and determining action.

Basic principles, which should govern the operation of the service program of physical education, were gleaned from a survey of the literature relating to broad administrative principles. The works of such authorities as: Cobb (3), Cureton (5), Larson (13), McCormick (16), Nash (20), Nixon and Cozens (23), Price (24), Sharman (25), Voltner and Esslinger (32), Williams (33), and Williams and Brownell (34) served as bases for determining principles.

The principles were expressed as statements, together with the various references from which the principles were derived. Each of the broad administrative principles was then clarified and amplified. In order to prevent the repetitious quoting of authorities by summarizing each of their statements which had a direct bearing on a specific principle, each authority was given a code number. This code number, followed by a page number, indicated the source of reference material. This technique, shown in operation, gave clear and concise supporting evidence for each of the 53 broad administrative principles.

Principle: An individual participates in those activities in which his needs and interests are satisfied (9, *p. 183;* 27, *p. 171;* 33, *p. 108;* 34, *pp. 228-29*).

When an individual attempts to satisfy a want or need the resultant effort to resolve the tension leads to activity. If the resultant activity terminates in pleasurable experiences, the individual will tend to repeat those activities

giving satisfaction and to avoid those activities resulting in unsatisfactory or unhappy experiences.

Standards commensurate with the needs and basic administrative principles were developed, established, and validated by means of authoritative literature and a panel of ten recognized authorities in the field of physical education. Statements of standards were drawn from the works of Hughes (9), LaPorte (12), Luehring (14), Sharman (27), and the National Facilities Conference (22).

The authorities comprising the panel of experts were chosen on the bases of their qualifying through the following criteria: 1. Approval by the sponsoring committee; 2. Director of a service program or allied work in the field of physical education; 3. Having at least ten years experience in his field; 4. Having a doctorate degree; and 5. Having held office in the College Physical Education Association, served on research committees, or having contributed to the literature in the field of physical education.

A list of 66 standards was submitted to each member of the panel requesting him to select the optimal standard (indicative of the highest practical level of achievement with reference to a specific standard) and the essential standard (indicative of the lowest acceptable level of achievement with reference to a specific standard). Since each standard involved a multiple choice selection, every member of the panel was presented an opportunity to draw fine distinctions between the optimal and essential standards. An example of the jury technique is shown with reference to the standard involving professional preparation (Table 1).

Table 1

The director of physical education should have:	Optimal	Essential
A. A doctorate degree	10	
B. A medical degree		
C. A Master's degree		8
D. A Bachelor's degree		2
E. A training school certificate		
F. No degree		
G. Other		

Optimal: The director of physical education should have a doctorate degree.

There are many factors which are operative with reference to the qualifications required for a director of physical education. However, other factors being equal, adequate professional preparation should be a major consideration. There was full agreement among the members of the panel that this should be the optimal standard.

Essential: The director of physical education should have a Master's degree.

Although other qualifications should be given consideration with reference

to the position of director of physical education, a large majority (80%) of the jurors selected this as the essential standard.

Since the standards were practical rather than theoretical standards, it was possible for institutions to exceed the optimal standard in many instances. Thus, institutions could be placed on five different levels of achievement; above the optimal, equal to the optimal, between the optimal and the essential, equal to the essential or below the essential standard. The standards thus established and validated served as bases for evaluating the physical education service programs in the colleges and universities of New York State.

The present status of the service programs of physical education was determined by a questionnaire which was sent to the 46 institutions comprising the study. There was 100 per cent return of the questionnaires.

The function of the questionnaire was to furnish sufficient data in order that a representative sampling of institutions of higher education might be obtained for further study. Under the heading of General Information, 7 items were considered including enrollments; Administration and Supervision contained 11 items; Institutional Requirements, 9 items; Course Requirements, 10 items; Attendance, 7 items; Staff, 4 items; Program, 10 items; Classification of Students, 5 items; Budget, 3 items; Facilities, 13 items; and Equipment, 8 items.

In order to evaluate the data contained in the questionnaires with reference to obtaining a representative sampling of institutions for the purpose of further study, a rating scale (from 10 to 0 points) was developed, based upon the optimal and essential standards established in the study. In all instances, the optimal standard received a value of eight points and the essential standard received a value of four points. Variations above and below these two constants received corresponding score values commensurate with their levels.

Arithmetic mean scores were obtained for each of the 12 major headings: Enrollment, Administration and Supervision, Institutional Requirements, Course Requirements, Attendance, Staff, Program, Classification, Budget, Facilities, Equipment and Total Mean Score. On the bases of these mean scores, the institutions were ranked. An adequate and representative sampling was obtained by selecting for further study, the highest ranking institution, the median institution and the lowest ranking institution in each of the major headings under consideration.

In addition, a minimum of one institution was selected from each of eight geographical areas: northwest, north central, northeast, southwest, south central, southeast, east central and metropolitan area. Fourteen institutions constituted the representative sampling. Excluding geographical considerations, these 14 institutions were found to be represented 43 times in the 12 major headings under consideration.

Evaluation of the Service Programs

The 14 institutions comprising the representative sampling were subjected to further study and analyses were made with reference to their over-all physi-

cal education program. This involved a personal visitation and survey of the institution being studied. Additional data were collected that did not lend themselves to being incorporated in the questionnaire, supplemented by considerable time being spent at each institution observing instructors and class instruction, surveying facilities, and conferring with administrators.

The additional data, in conjunction with the data collected from the questionnaires, were analyzed and compared to the standards. The same rating scale which was used to obtain a representative sampling from the questionnaire data was used to evaluate these 14 institutions. The optimal standard received a rating of eight points, the essential standard four points, variations above and below these two constants received corresponding point values from ten to zero. Thus, in the matter of having their physical education service programs evaluated, institutions could be placed at five different levels of achievement.

With the exception of geographical location, physical education enrollment, and budget, mean scores were obtained for each of the institutions in the following categories: Administration and Supervision, Institutional Requirements, Course Requirements, Attendance, Staff, Program, Classification of Students, Facilities, Equipment, and Total Mean Score. On the bases of these mean scores, the various institutions were ranked.

Reliability of the data contained in the questionnaires was determined by product-moment coefficients of correlations. Rank difference correlations between questionnaire data and visitation data were computed for each of the fourteen institutions comprising the evaluation study. The rank order coefficients of correlations (rhos) obtained from the data were transmuted into product-moment coefficients of correlations (r's). These were tested at the .01 level for significance in accordance with the Null Hypothesis. These data are shown in Table 2.

TABLE 2

Levels of Significance of Scores Obtained from the Questionnaires and from Personal Visitation of the Institution[1]

Major Areas	Rhos	R's	.01 Level
Enrollment	.9737	.976	Significant
Administration	.8198	.833	Significant
Requirements	.8968	.905	Significant
Course Requirements	.7330	.749	Significant
Attendance	.9286	.934	Significant
Staff	.7088	.725	Significant
Program	.7319	.748	Significant
Classification	.7935	.807	Significant
Budget	1.0000	1.000	Significant
Facilities	.9473	.951	Significant
Equipment	.9077	.914	Significant
Total Mean Score	.9165	.923	Significant

[1]In order for the coefficients of correlation to be significant at the .01 level, scores must equal or exceed .6614 for 14 cases.

All institutions comprising the evaluation study were evaluated with reference to meeting optimal and essential standards in each major area under consideration. The data for the evaluation of institutions in Administration and Supervision are shown in Table 3 and Figure I. In the area of Administration and Supervision, it will be noted that 11 (78%) of the institutions exceeded the essential standard and three (22%) of the institutions did not meet the essential (minimal acceptable) standard.

TABLE 3

Summary of the Mean Scores from Personal Visitations of Institutions Comprising the Evaluation Study[1]

Inst	Admn	Reqs	CReq	Attn	Staff	Prog	Class	Facil	Eqpt	Total
8	6.80	6.80	6.40	6.40	6.50	5.50	6.00	7.53	6.00	6.49
11	5.80	3.30	5.80	5.00	3.62	6.25	4.00	5.76	5.80	5.13
13	6.80	5.60	8.40	7.20	8.10	6.75	8.00	7.18	8.00	7.14
15	3.80	2.80	3.00	3.60	7.50	5.00	3.50	4.12	4.00	4.53
17	5.00	2.70	3.20	5.20	6.50	4.22	3.75	3.76	6.00	4.63
20	2.80	3.40	2.40	2.00		2.00	0.50	1.08	3.00	1.91
21	5.00	2.00	2.80	5.20	3.50	1.75	1.00	2.53	5.25	3.30
25	5.00	5.20	4.40	6.40	7.00	4.22	1.75	2.75	4.73	4.94
27	4.80	2.40	2.00	2.80	8.00	2.22	2.00	4.24	4.00	4.04
28	6.90	5.20	6.00	6.80	8.00	4.66	8.50	5.30	5.00	6.43
29	4.40	3.00	3.73	5.00	5.50	2.75	3.50	3.76	5.57	3.92
32	4.40	3.60	2.80	1.80	5.50	5.33	1.50	3.65	8.00	4.45
43	3.00	2.00	3.25	3.80	8.00	3.11	3.25	4.23	5.24	4.38
46	4.60	4.40	4.60	4.20	8.00	4.22	2.25	5.17	8.00	5.34

[1]Table 3 shows the mean scores of institutions designated by code numbers 8, 11, 13, etc. for the various items under the major headings of: Administration and Supervision, Institutional Requirements, Course Requirements, Attendance, Staff, Program, Classification of Students, Facilities, Equipment and the Total Mean Score of each institution. Each item under consideration received a point value from ten to zero. Note: No score is found under Staff for institution number 20. Individuals taking required physical education were placed in the activity courses for physical education majors, consequently no valid estimate could be made of the staff teaching in the service program.

As an additional part of the study, each individual institution was evaluated on the bases of meeting optimal and essential standards in each of the major areas comprising the overall physical education program. The data for evaluating the highest ranking institution in the mean of the Total Mean Score (average score) are shown in Table 3 and Figure II. It will be noted that institution No. 13 exceeded the optimal standard in the areas of Course Requirements and Staff; equally the optimal standard in the areas of Classification of Students and Equipment, and exceeded the essential standard in all other areas.

The data for evaluating the median institution in the mean of the Total Mean Score (average score) are shown in Table 3 and Figure III. It will be noted that institution No. 17 exceeded the essential standard in six areas: Administration and Supervision, Attendance, Staff, Program, Equipment and

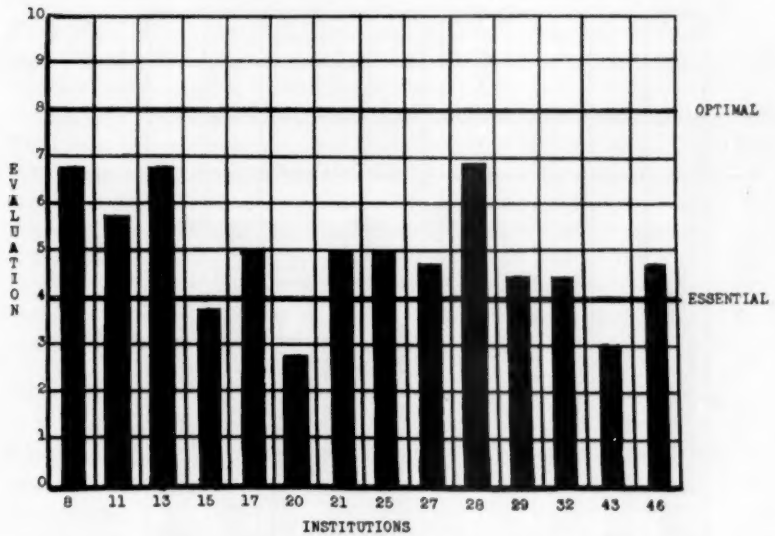

FIGURE I. Evaluation of Institutions in Administration and Supervision.

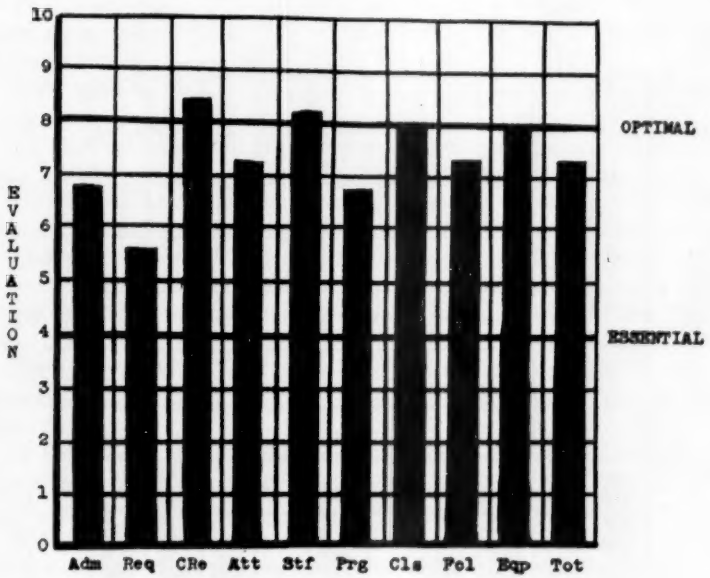

FIGURE II. The Evaluation of Institution No. 13.

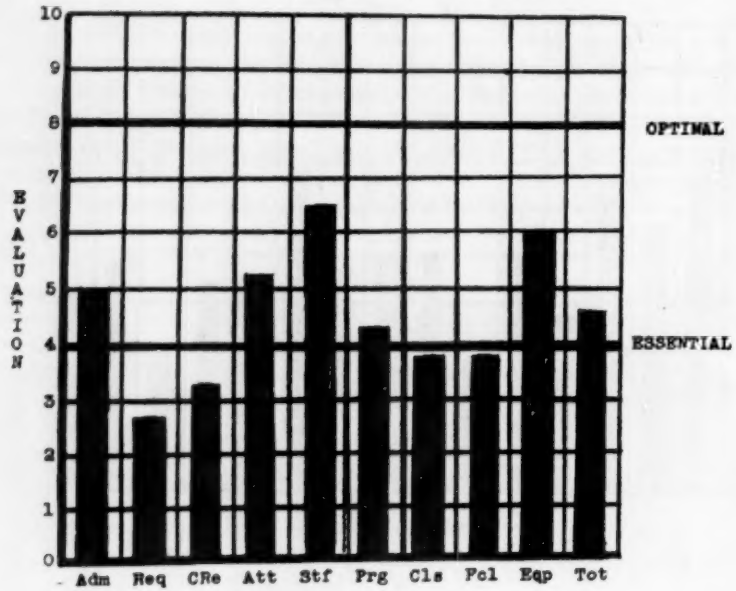

FIGURE III. The Evaluation of Institution No. 17.

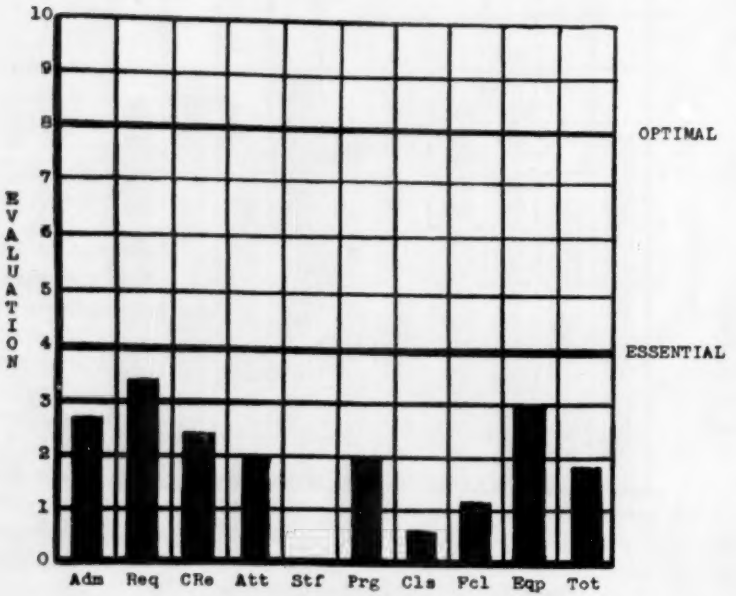

FIGURE IV. The Evaluation of Institution No. 20.

Total Mean Score. This institution fell below the essential (minimal acceptable) standard in four areas: Institutional Requirements, Course Requirements, Classification of Students and Facilities.

The data for evaluating the lowest ranking institution in the mean of the Total Mean Score (average score) are shown in Table 3 and Figure IV. It will be noted that institution No. 20 fell below the essential (minimal acceptable) standard in all areas under consideration. No score is found under the heading of Staff for this institution. Individuals taking required physical education were scheduled in the activity courses for students majoring in physical education. Consequently, no valid estimate could be made of staff members actually teaching in the required or service program of physical education.

Findings

1. Returns from the questionnaires showed that 86.96 per cent of the institutions of higher education had a required or service program in physical education while 13.04 per cent had no physical education requirement for graduation.

2. Of those institutions having a physical education requirement for graduation, 15.00 per cent required two semesters, 2.50 per cent required three semesters, over half, or 62.50 per cent required four semesters, 2.50 per cent required five semesters, 7.50 per cent required six semesters, 5.00 per cent required seven semesters and 5.00 per cent had an elective course as a result of the participation of students in ROTC programs.

3. In New York State, 45.95 per cent of the institutions of higher education gave credit for physical education while 54.05 per cent of the institutions required physical education for graduation but gave no credit for such courses.

4. The type of institution showed some interesting results regarding credit for physical education courses. It was found the 60.00 per cent of the universities gave credit while 40.00 per cent did not give credit, 46.66 per cent of the liberal arts colleges gave credit while 53.33 per cent did not give credit, 33.33 per cent of the teachers colleges gave credit and 66.66 per cent did not give credit.

5. The percentages of institutions that met or did not meet the optimal and essential standards, in the various areas under consideration, are shown in Table 4.

6. In the area of *Administration and Supervision,* 78 per cent of the institutions exceeded the essential standard while 22 per cent fell below the essential standard.

7. With reference to *Institutional Requirements,* 36 per cent exceeded the essential standard and 64 per cent failed to meet the essential standard.

8. When considering *Course Requirements,* 43 per cent exceeded the essential standard but 57 per cent of the institutions fell below the essential standard.

TABLE 4

Percentages of Institutions That Met or Did Not Meet the Optimal and Essential Standards

Area	Above Optimal	Optimal	Between Optimal and Essential	Essential	Below Essential
Administration			78		22
Institutional Requirements			36		64
Course Requirements	7		36		57
Attendance			64		36
Staff	7	29	50		14
Program			64		36
Classification	7	7	7	7	72
Facilities			57		43
Equipment		22	57	14	7
Total Mean Score			78		22

9. In the area of *Attendance*, 64 per cent of the institutions were above the essential standard while 36 per cent were below this standard.

10. When considering teaching *Staff*, 86 per cent of the institutions exceeded the essential standard but only 14 per cent fell below the essential standard.

11. In 64 per cent of the institutions, the basic physical education *Program* exceeded the essential standard and 36 per cent were below the essential standard.

12. In the area of *Classification* of students, 28 per cent of the institutions equalled or exceeded the essential standard and 72 per cent fell below this standard.

13. When considering *Facilities*, 57 per cent exceeded the essential standard and 43 per cent were below the essential standard.

14. In the matter of *Equipment*, 93 per cent of the institutions equalled or exceeded the essential standard and only 7 per cent were lacking in essential equipment.

15. When considering the *Total Mean Score* (average score), 78 per cent of the institutions exceeded the essential standard and 22 per cent fell below the essential standard.

Conclusions

1. The evaluation of the required or service programs of physical education in institutions of higher education in New York State showed wide variations in the over-all program from excellent to poor.

2. The questionnaire data received from the institutions were highly reliable. The coefficients of correlation between questionnaire data and visitation data ranged from 1.000 to .725.

3. A high degree of stability existed between the questionnaire data and visitation data as indicated by correlations for each major area surpassing the .01 level of significance.

4. The percentage of institutions of higher education in New York State requiring physical education for graduation was much lower than has been found to exist in similar institutions throughout the United States.

5. The percentage of institutions of higher education in New York State giving credit for physical education courses was much lower than has been found to exist in similar institutions throughout the United States.

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(Submitted 3/15/54)

Measurable Traits of Personality and Incidence of Somatic Illness Among College Students

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Abstract

This investigation attempted to explore the possibility of certain relationships existing between physical illness and personality in university men and women. Ninety-five subjects were given the short group form of the Minnesota Multiphasic Personality Inventory. These subjects were classed as *repeaters* or *non-repeaters* in terms of the frequency of infirmary visits for somatic complaints during one school year. Relationships between the dichotomous categories of physical health or illness and the MMPI scales of emotional health were determined by the point bi-serial method. In addition, t ratios were computed to test the reliabilities of the differences between group means for the nine scales of personality. The findings suggest significant associations between certain aspects of personality and the incidence of complaints of physical illness.

RECENT MARKED ADVANCES in psychosomatic medicine and its related disciplines have drawn sharp attention to the interdependency of the physical and the psychic components of the human organism (2, 3, 10, 26, 28). While complete elaboration of the mechanism and degree of this inter-relationship is yet to be achieved, substantial progress has been realized in the establishment of certain fundamental concepts of biochemical, physiological, and pathological reaction to emotional stress in humans. There appears to be rather general agreement that emotional stresses are mediated through the nervous and endocrine systems, usually resulting in acceleration of thoracolumbar and adrenal activity (1, 8, 9, 11, 27, 30, 31, 33).

Psychosomatic illness may be regarded as an adaptive reaction of the organism to protracted emotional tensions and frustrations. Thus, it is recognized that the onset and course of certain physical illnesses may be influenced by chronic emotional disturbances. Conditions in which psychic factors can play an etiological role include peptic ulcer, colitis, essential hypertension, asthma, allergic rhinitis, menstrual disorders, certain collagen diseases, migraine, diabetes mellitus, acne, and other pathologies (2, 3, 8, 19, 28, 29, 31).

The rich research potential of psychosomatics has recently been dealt with by Grinker (15) and Hoch (20) with emphasis on the wide implications for new knowledge in this area. Lacey and Van Lehn (22), Grace and Graham (14), and Frankle (12) have all reported studies which attempted to probe more deeply into the specificity of organic response to certain types of emotional stress.

The etiologic importance of chronic repression of emotions during childhood and adolescence has been made abundantly clear in the profusion of psychosomatic literature (2, 3, 8, 28, 32). Lemkau (23) has recently emphasized the high significance of mental health during the years of rapid growth. Accumulating data indicate the trend toward increased incidence of psychosomatic conditions among the younger age groups (8).

Accordingly, recognizing the diversity of emotional problems faced by college students, and apprised of the possibility that certain of these problems may have their origins in early childhood—and, thus, may have manifest themselves in somatic illnesses—it was decided to investigate the relationship existing between certain psychic factors and the incidence of physical illness among a typical university population.

Purpose of the Study

The primary purpose of this investigation is to determine the nature and degree of relationship holding between certain measurable traits of personality and the incidence of somatic illness among men and women university students.

A collateral objective is to provide data which may be of value to health educators, health counselors, physicians, guidance personnel, clinical psychologists, and others concerned with the health status and behavior of college students.

Procedure

The sample for this study was derived from a population of 7,400 college men and women, each of whom had visited the university infirmary at least once during the period from July 1, 1952 to June 30, 1953. During this year, students reported to the infirmary for a total of 46,790 visits, with a mean of six visits per student. The modal number of visits, affording a more valid measure of central tendency in this instance, was one. Complete data on the nature of the illness and the number of infirmary visits were available for each student.

Stratification of the sample population was effected at the 10th and 90th percentiles in order to derive two contrasting categories, or sub-samples, in terms of physical health and physical illness as reflected by frequency of infirmary visits. Thus, the first group included those students who ranked above the 90th percentile in the number of infirmary visits. This group was referred to as the *Repeater* group and could be considered to manifest an inordinately high incidence of signs and/or symptoms of physical illness.

The second group was made up of students who ranked at or below the 10th percentile in frequency of visits. These subjects were considered to comprise the *Non-Repeater group* and could be regarded as enjoying average physical health. Within each of these two sub-samples, there were two subgroups—one of men and one of women. The subjects were randomly selected for voluntary participation in the study from within each of these sub-

samples. A total of 95 subjects were included in the sample for this investigation. Subjects were distributed as follows: Men Repeaters, 31; Women Repeaters, 19; Men Non-Repeaters, 15; Women Non-Repeaters, 30. Subjects who received treatment for certain chronic conditions, for emotional problems, or who visited the infirmary for preventive measures were excluded from the sample studied. Subjects who had been treated for injuries sustained in minor accidents were included since available evidence indicates that psychological factors may lead to accidents in some cases (5). However, these subjects ranked above the 90th percentile in frequency of infirmary visits even when visitations arising from accidental causes were not counted.

The Minnesota Multiphasic Personality Inventory was selected as a suitable psychometric instrument for the purpose of this study. The shortened version of the group form of this inventory affords assessment of nine important phases of personality. Although the very nature of the traits measured by personality tests tends to lower the reliability of such techniques, acceptably high test-retest coefficients have been reported for the Minnesota Multiphasic Personality Inventory by Cottle (7) and Hathaway and McKinley (18). The work of McKinley and Hathaway (25) and Guthrie (17) indicates that the instrument possesses adequate validity. Lough and Green (24), Bursch (4), and Clark (6) have all found the inventory to be useful in the assessment of emotional disturbances among college populations.

The group form of the inventory was administered to the subjects in the Research Laboratory of the College of Physical Education and Health under the supervision of trained personnel. In order to minimize the operation of situational variables, participation in the investigation was entirely voluntary and, during the week of testing, subjects chose whatever time was most convenient for them to come to the laboratory.

On the basis of responses recorded by each subject for 366 items of the inventory, raw scores were converted to T-scores using previously established norms (18) and T-scores were derived for each of the nine personality scales. These scales are hypochondriasis, depression, hysteria, psychopathic personality, masculinity-femininity, paranoia, psychasthenia, schizophrenia, and hypomania.

Results and Discussion

Analysis of the obtained data involved two statistical techniques. Small sample formulae were used when N was 50 or less (13). First, coefficients of correlation were calculated by the point bi-serial method. In this manner the degree of relationship existing between the dichotomous classification of repeated somatic illness and relative somatic health and the nine scales of emotional health could be estimated. Recognizing the possibility for deriving fiducial results by assuming normality of distribution of the dichotomized variable (21), bi-serial coefficients of correlation were calculated by the formula for r_{pbi} (16). Secondly, critical ratios were computed to test the reliability of the differences obtaining between group means, in terms of T-scores,

for the nine clinical scales of personality. Thus, the significance of the intergroup variances in mean scores for the various personality traits could be determined.

The significance of the differences between mean scores for Repeaters and Non-Repeaters, Men Repeaters and Men Non-Repeaters, and Women Repeaters and Women Non-Repeaters for each of the nine measures of emotional health are illustrated in Tables 1, 2, and 3. In the main, as scores deviate from the T-scale mean of 50, they tend to reflect emotional problems underlying the personality trait assessed (18).

From Table 1, it is apparent that differences between means of the Repeater and Non-Repeater groups were significant for hypochondriasis, hypomania, psychopathic personality, and depression.

TABLE 1

Intergroup Comparisons of Repeaters and Non-Repeaters in Terms of Means and Critical Ratios

Scale	Group	N	M	t
Hypochondriasis	Repeater	50	52.82	3.81[2]
	Non-Repeater	45	46.11	
Depression	Repeater	50	52.82	2.03[1]
	Non-Repeater	45	48.36	
Hysteria	Repeater	50	58.96	1.62
	Non-Repeater	45	56.07	
Psychopathic Personality	Repeater	50	53.90	2.04[1]
	Non-Repeater	45	49.67	
Masculinity-femininity	Repeater	50	55.020	1.71
	Non-Repeater	45	51.533	
Paranoia	Repeater	50	55.24	.47
	Non-Repeater	45	54.40	
Psychasthenia	Repeater	50	51.28	1.59
	Non-Repeater	45	48.04	
Schizophrenia	Repeater	50	51.92	1.35
	Non-Repeater	45	49.36	
Hypomania	Repeater	50	58.98	2.64[2]
	Non-Repeater	45	54.02	

[1]Significant at the .05 level of confidence.
[2]Significant at the .01 level of confidence.

Data from Table 2 indicate that, for the sub-groups Men Repeater and Men Non-Repeater, none of the obtained differences between means was significant for the assessed personality traits. On the other hand, Table 3 shows significant differences existing between means for hypochondriasis and psychopathic personality for Women Repeaters and Women Non-Repeaters.

Thus, for the total sample studied, significant differences in four important measures of personality were observed when the mean scores of the Repeater group were compared with means of the Non-Repeater group. Subjects whose annual frequency of infirmary visits placed them above the 90th

TABLE 2

Intergroup Comparisons of Men Repeaters and Men Non-Repeaters in Terms of Means and Critical Ratios

Scale	Group	N	M	t
Hypochondriasis	Men Repeater	31	51.94	.71
	Men Non-Repeater	15	50.20	
Depression	Men Repeater	31	54.23	.97
	Men Non-Repeater	15	50.30	
Hysteria	Men Repeater	31	58.90	.04
	Men Non-Repeater	15	58.80	
Psychopathic Personality	Men Repeater	31	53.45	.60
	Men Non-Repeater	15	51.33	
Masculinity-femininity	Men Repeater	31	58.07	.47
	Men Non-Repeater	15	56.47	
Paranoia	Men Repeater	31	52.94	.28
	Men Non-Repeater	15	52.13	
Psychasthenia	Men Repeater	31	51.28	.42
	Men Non-Repeater	15	50.20	
Schizophrenia	Men Repeater	31	51.68	.12
	Men Non-Repeater	15	51.33	
Hypomania	Men Repeater	31	59.97	1.88
	Men Non-Repeater	15	54.47	

TABLE 3

Intergroup Comparisons of Women Repeaters and Women Non-Repeaters in Terms of Means and Critical Ratios

Scale	Group	N	M	t
Hypochondriasis	Women Repeater	19	54.26	3.54[2]
	Women Non-Repeater	30	44.07	
Depression	Women Repeater	19	52.16	1.59
	Women Non-Repeater	30	47.13	
Hysteria	Women Repeater	19	59.05	1.74
	Women Non-Repeater	30	54.70	
Psychopathic Personality	Women Repeater	19	54.63	2.22[1]
	Women Non-Repeater	30	48.88	
Masculinity-femininity	Women Repeater	19	50.05	.39
	Women Non-Repeater	30	49.07	
Paranoia	Women Repeater	19	59.05	1.41
	Women Non-Repeater	30	55.53	
Psychasthenia	Women Repeater	19	50.79	1.15
	Women Non-Repeater	30	46.97	
Schizophrenia	Women Repeater	19	52.32	1.37
	Women Non-Repeater	30	48.37	
Hypomania	Women Repeater	19	57.37	1.22
	Women Non-Repeater	30	53.80	

[1]Significant at the .05 level of confidence.
[2]Significant at the .01 level of confidence.

percentile of the university population distribution showed significantly higher scores for hypochondriasis, hypomania, psychopathic personality, and depression than subjects who visited the infirmary only once. Hypochondriasis is characterized by abnormal concern about bodily function; hypomania is typified by marked overproductivity in thought and action; psychopathic personality describes the individual with shallow emotional responses, inability to benefit from experience, and disregard of social mores; and depression is characterized by poor emotional morale with a sense of uselessness and an attitude of undue pessimism (18).

Coefficients of correlation between the nine measures of personality and the frequency of physical illness, as reflected in the number of infirmary visits, are set forth in Table 4.

TABLE 4

Correlations (r_{pbi}) Between Measures of Personality and Somatic Illness

Scale	Repeater Non-Repeater	Men Repeater Men Non-Repeater	Women Non-Repeater Women Repeater
Hypochondriasis	.36[2]	.11	.51[2]
Depression	.24[1]	.14	.24
Hysteria	.16	.01	.27
Psychopathic Personality	.20[1]	.08	.33[1]
Masculinity-femininity	.17	.07	.06
Paranoia	.05	.04	.20
Psychasthenia	.16	.06	.17
Schizophrenia	.14	.02	.20
Hypomania	.26[1]	.27	.19

[1]Significant at the .05 level of confidence.
[2]Significant at the .01 level of confidence.

As might well be anticipated, owing to the overlapping nature of the variables, the relationship between hypochondriasis and repeated complaints of physical illness was higher than that for any other pair of variables. For the total sample studied, coefficients of correlation were significant for hypochondriasis, hypomania, psychopathic personality, and depression, as related to frequency of somatic illness. An r_{pbi} of .36 for hypochondriasis and physical illness would seem to indicate the existence of a moderate positive relationship between hypochondriasis and physical illness. Hypomania (r_{pbi} of .26), psychopathic personality (r_{pbi} of .20) and depression (r_{pbi} of .20) all would appear to have a low positive relationship to frequency of physical illness. In light of the character of the variables, coefficients of this order would seem to be meaningful in describing certain psychosomatic relationships. It is also noteworthy that analysis of the data by the point bi-serial method of correlation attained results consistent with those derived by determination of the significance of the differences between means. As with the findings derived from calculation of critical ratios, coefficients of correlation indicated significant relationships obtaining between somatic illness and the MMPI measures

of hypochondriasis and psychopathic personality for Women Repeaters and Women Non-Repeaters. Again, data for Men Repeaters and Men Non-Repeaters yielded no significant or sizable coefficients of correlation. This would seem to suggest that an association between certain aspects of personality and physical illness is more prevalent among young women than among young men. However, variations in N, and possibly the operation of selective or unknown factors, may have tended to emphasize an apparent insignificant relationship between the variables among college men.

Conclusions

On the basis of statistical analysis of the obtained data, and within the limitations of the sample and the techniques used to determine the variables, the following conclusions would seem justifiable:

1. There is a positive and significant relationship holding between the existence of certain emotional problems and the frequency of somatic illness.
2. This relationship appears to be moderate in degree for hypochondriasis; and low for hypomania, psychopathic personality, and depression.
3. There appears to be a greater tendency for these relationships to occur among young women than among young men.

Acknowledgment

The investigators are indebted to Dr. S. E. Ayers, director; Dr. J. H. Closson, University physician-neuropsychiatrist; and Mrs. Betty P. Maddox, executive assistant; of the Student Health Department, College of Physical Education and Health, University of Florida, for their generous co-operation in the planning and conduct of this study.

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(Submitted 7/7/54)

Relationship of Selected Tests with Energy Metabolism and Swimming Performance

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Abstract

Forty-one varsity swimming team candidates were tested using a battery of 52 swimming, cardiovascular, and energy metabolism measures, the latter being obtained during all-out static swimming. All of the measures were intercorrelated, and metabolic and swimming performance criteria were established. Multiple regression analyses were completed to select the most representative measures of each of the criteria from each of the testing areas. The better measures from each of the testing areas, as determined by the multiple regression analyses, were combined in further multiple regression analyses to determine the relative importance of the measures to 100-yd. and 440-yd. swimming performance.

The results show that energy metabolism tests are significantly related to 100-yd. and 440-yd. swim times but are reflected also in simpler tests of a practical nature which any teacher or coach can administer. The 100-yd. crawl swim was predicted to the extent indicated by the multiple $R = .815 \pm 4.99$ secs. and the 440-yd. swim, $R = .865 \pm 38.45$ secs. In the 100-yard swim, endurance is shown to be more important than the relative contribution of arm stroke and leg kick. The great importance relatively of the leg kick and gliding ability is shown.

THE OPINIONS OF teachers and coaches of swimming regarding the importance of the abilities associated with speed swimming vary rather widely. It was the purpose of this study to further clarify the relationship of selected tests known or suspected of being associated with swimming performance. Specifically, the study was undertaken to determine the inter-relationship and relative importance of the energy metabolism measures obtained in all-out static swimming,[1] of the selected cardio-vascular tests, and of the practical diagnostic swimming tests to 100-yard and 440-yard swimming performance.

Cureton (6, 10, 11, 14, 16, 17) derived the practical diagnostic swimming tests and demonstrated their relationship to swimming performance. Liljestrand and Lindhard (31, 33) and Liljestrand and Stenström (32) first measured the energy cost of swimming. Karpovich, et al. (21, 26, 27, 28) further studied the energy cost of swimming the various strokes and demonstrated the applicability of Sargent's prediction (37). McCurdy and Larson (34) and Cureton (12) determined the relationship of 45 selected circulatory respiratory tests to swimming performance.

[1]All-Out Static swimming is construed to mean swimming in place (restrained by a rope) at the maximum rate for one minute following a 100-yard drop-off test.

Cureton (8, 11, 14) and his associates (23, 29) studied the differences between expert and ordinary swimmers and tested samples of swimmers with batteries of swimming performance, physique, and cardiovascular tests to gain insight into the factors necessary for top-notch swimming performance. Expert swimmers excelled the average swimmers in organic condition, stroke mechanics, and co-ordination tests. Co-ordination ability, gliding efficiency, and leg kicking efficiency, in that order, were found to be relatively more important to 20-yd. crawl performance; arm stroke efficiency and co-ordination efficiency to 100-yd. crawl performance and thigh flexion strength and the pulse rate immediately following breath holding after 2 minutes' exercise to 440-yd. performance. In the present study, the energy metabolism measures were included in a test battery designed to include the measures found to be closely related to swimming performance in the earlier studies (6, 12, 14, 16, 23, 24, 26, 27, 29, 34, 40).

Methodology

Forty-one college swimmers between the ages of 17 and 23 years, consisting of 37 varsity team candidates and four champions, were tested on a battery of 52 metabolic, cardiovascular, and swimming tests. The basic measures were intercorrelated by machine techniques[2] (22) and the data checked for linearity (35). Two sets of criteria were set up: 1. The metabolic criteria, consisting of the two metabolic measures most closely related to swimming performance—the gross oxygen intake and the gross oxygen debt;[3] 2. The swimming performance criteria, consisting of the 100-yd. and 440-yd. swimming times. Multiple regression analyses (36) were then completed to select the most representative measures from each of the testing areas. The better measures from each of the testing areas, as determined by the multiple regression analyses, were then combined in further multiple regression analyses to determine the relative importance of the measures to the respective criteria.

Pool Metabolic Procedures. The subject reported to the pool in the morning in the basal state and warmed up in his usual manner preparatory to swimming competitively. Following warm-up, a leather gymnastic type belt was placed around his waist, his nose taped shut, and a swimmer's noseclip applied over the tape. The subject then swam the Cureton 100-yd. drop-off test[4] (6) using the crawl stroke with a push-off start. At the end of the test the helmet with the attached mouthpiece was placed on the subject's head and the restraining rope snapped on the rear of the belt (see Figure I).

A one-minute static swim, with the subject maintaining his maximum rate, was used for the collection of the exercise gas sample. The time between the

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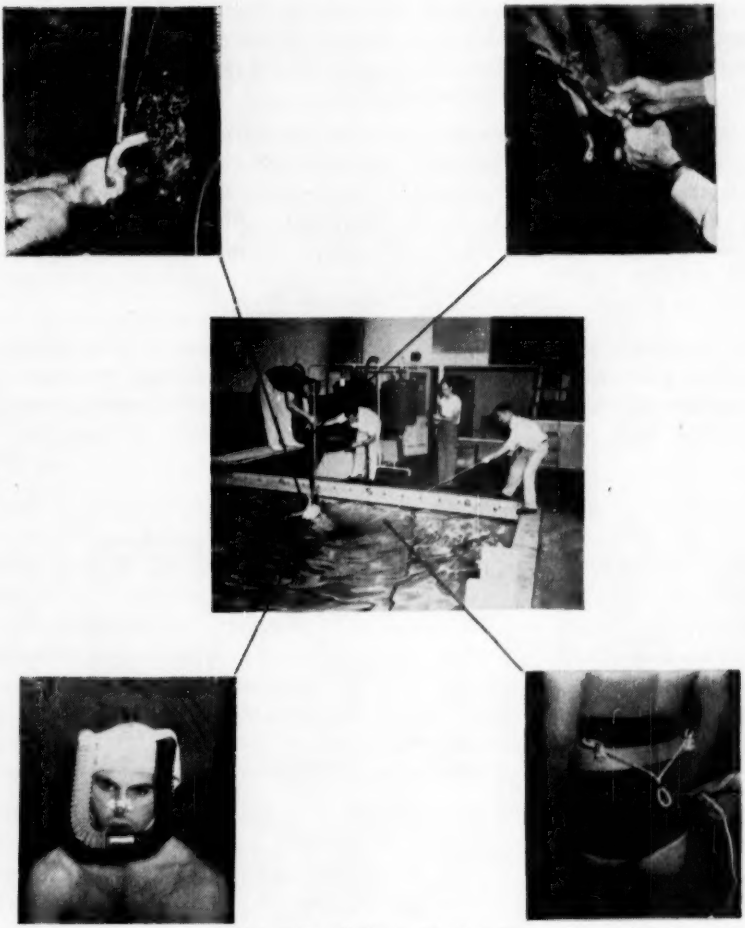
[2]Correlations were computed using International Business Machines.

[3]The term "gross" is used to indicate that the sitting equivalent has not been subtracted.

[4]The term "drop-off" means that each successive 25-yard pool length was swum at maximum speed.



University of Illinois Physical Fitness Research Laboratory.

FIGURE I. Equipment Used in the Collection of Energy Metabolism Data in Static Swimming. *Top left:* Head immersed during static swim. *Top right:* Three-way valve attached to intake bag. *Bottom left:* Helmet with tubes attached to the two-way breathing valve. *Bottom right:* Gymnasic-type belt with rope attachments for restricting forward motion.

end of the drop-off and the start of the one-minute swim was standardized at 30 sec. Fifteen to 27 sec. after the finish of the drop-off, the two-way mouthpiece, which permits the intake of fresh air and the collection of expired gas, was placed in the subject's mouth. The subject then moved into position and exactly 30 sec. after the finish of the drop-off the valve to the exercise Douglas bag was opened and the expired gas collected for one minute as the subject swam in place held by the restraining rope.

At the end of the one-minute static swim, the valve to the exercise Douglas bag was closed and the circuit switched to the recovery bags for the collection of the recovery gas (see Figure II). The recovery time was standardized at 15 min. with a 5-min. first recovery bag and a 10-min. second recovery bag. Pulse rate and blood pressure measurements were taken during the 2nd, 5th, 10th and 15th minutes. The metabolic variables were measured and computed using the procedures described by Consolozio (5).

The Test Battery. The test battery, totaling 52 variables, included all of the brachial pulse wave measures, quiet and post exercise blood pressures and pulse rates taken at standardized times, 100-yd. and 440-yd. crawl swimming

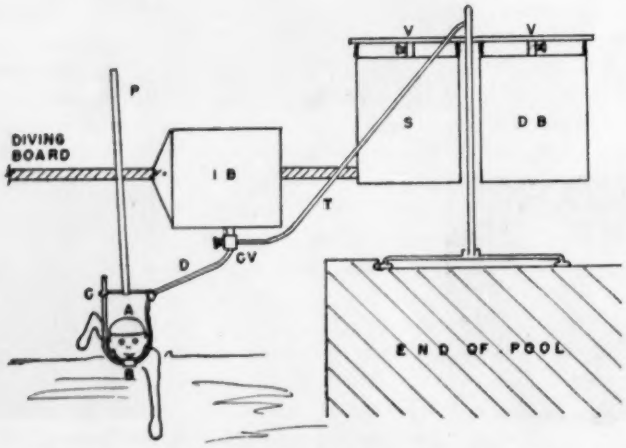


FIGURE II. Diagram of Pool Apparatus. A—Helmet; B—Two-way Valve; C—Intake Tube; D—Collection Tube; CV—Three-way Valve; P—Supporting Pole; S—Surplus Gas Bag; T—Tube to Debt Bags; DB—Debt Bags; V—Valves to Individual Bags; IB—Intake, Douglas Bag. *Description of Circuit:* During the one-minute swim, the room air is taken in through tube C to the subject's mouthpiece connected to the two-way valve B. The expired gas, which can pass in one direction only, passes through tube D to the three-way valve CV and into the intake bag IB. At the end of the one-minute swim, valve CV is turned and all expired gas passes through tube T into the debt bags DB. The surplus bag S is used for collecting gas just previous to the one-minute swim.

times, the energy metabolism measures and the following swimming tests: 100-yd. drop-off, buoyancy, horizontal-vertical floating capacity, 24-ft. gliding time, arms alone 60-ft., legs alone 60-ft., co-ordination index, underwater distance, underwater time, and the total arm strokes and kicks completed in swimming 100-yd. The metabolic measures used were as follows: basal, respiratory quotient, ventilation, and oxygen intake; exercise (swim) respiratory quotient, ventilation, and gross and net oxygen intakes; gross and net oxygen debts and the oxygen requirement; gross oxygen intake divided by the body surface area and the gross oxygen intake divided by the kilograms of body weight.

Reliability. Owing to the rigorousness and tediousness of the metabolic testing, it was neither practical nor possible to obtain reliability coefficients. The reliability data presented in Table 2 are estimates computed by the standard error of measurement technique recommended by Goodwin (20), using the procedures outlined by Snedecor (38, 39). Three subjects were administered repeat trials on the measures obtained in the pool metabolic testing.

The swimming and cardiovascular measures administered other than during the pool metabolic testing period were measures with known, high reliability coefficients.

Curvilinearity of the Metabolic Measures. The statistical assumption of rectilinearity necessary for product-moment correlations and multiple regression analyses presented some difficulties. The oxygen intake and debt measures were found to plot curvilinearly with the swimming performance times, and with the swimming tests involving time. The F test (35) was applied to determine whether the hypothesis of linearity should be rejected. With the gross oxygen intake vs. 100-yd. swim times only was the F significant (2.41), at the 5-percent level, and the hypothesis rejected. The F values for the oxygen intake and debt, both gross and net, vs. the swimming tests involving time were in general high enough to question the hypothesis (35).

Dividing the oxygen measures by the kilograms of body weight or by the body surface area did not remove the curvilinearity of these measures as was found by Cureton in all-out treadmill run data (13). After considerable trial and error, it was found that the common logarithm values of the oxygen debt data plotted linearly with the swimming-performance data. In the oxygen-intake data, the log values straightened out the data with the exception of the trials of the poorer performers. Retest of the data with the F test yielded low values indicating the hypothesis of linearity could not be rejected when the common log values were substituted for the metabolic measures.

The correlations quoted involving metabolic measures and swimming performance were computed using the log values for the metabolic measures. It was found in computing the correlations with both the true values and the log

values that where the data were scattered the use of the log values had little effect or lowered the relationship. Where the relationship appeared reasonably good, however, the log values raised the relationship considerably. Both sets of correlations are presented.

TABLE 1

Repeat Trial Data, Tests Utilized Metabolic Testing Day

Test	Subject I M (5 trials)	Subject I σ Meas.	Subject II M (5 trials)	Subject II σ Meas.	Subject III M (3 trials)	Subject III σ Meas.
Basal R.Q.	.812	.016	.718	.018	.840	.021
Basal Ventilation (cu. ft. corrected)	2.411	.102	2.479	.166	2.845	.488
Basal O_2 Intake (l/min.)	.306	.014	.277	.018	.271	.042
Swim R.Q.	1.074	.044	1.076	.031	1.026	.043
Swim Ventilation (cu. ft. corrected)	2.502	.138	2.767	.117	2.210	.140
Swim Gross O_2 Intake (liters/min.)	2.794	.102	2.568	.157	2.631	.040
R.Q. First Recovery	1.266	.020	1.170	.024	1.357	.015
Gross O_2 Debt (liters)	9.478	.281	10.264	1.111	10.094	.230
O_2 Requirement (liters)	7.665	.406	8.043	.853	8.545	1.166
Gross Total Oxygen (liters)	12.272	.227	12.832	1.209	12.724	.439
100-Yd. Crawl Drop-Off Swim Time (secs.)	68.7	.68	62.4	.36	66.3	.77
Total Arm Strokes (in 100-yd. Drop-Off Swim)	86.0	2.66	76.6	2.21	78.3	3.18
Total Kicks (in 100-yd. swim)	215	8.1	179	4.6	195	10.7
100-Yd. Drop-Off (secs.)	4.7	.32	3.9	.38	5.1	.68
Sitting Pulse Rate (b./min.)	64	3.8	69	1.3	59	1.8
Sitting Heartometer Diastolic Blood Pressure (mm/Hg)	53.6	3.8	62.5	.5	54.0	5.0
Sitting Heartometer Systolic Blood Pressure (mm/Hg)	133.8	2.2	122.0	2.2	112.0	1.2
Pulse Rate, 5th Min. Recovery	89.0	2.0	109.0	1.0	113.3	4.8
Diastolic Blood Pressure (5th Min. Recovery (mm/Hg)	60.8	2.9	53.0	2.1	——	—
Systolic Blood Pressure 5th Min. Recovery	147.2	3.9	141.5	1.5	157.3	2.4
Pulse Rate, 10th Min. Recovery	87	1.9	102	1.2	106.6	2.7
Diastolic Blood Pressure 10th Min. Recovery	69.0	4.0	64.5	2.1	35.3	8.4
Systolic Blood Pressure 10th Min. Recovery	139.5	.6	128.0	3.6	128.7	5.2

TABLE 1-A

Means and Standard Deviations of the Basic Data

Variable	Mean	S.D.	Units
1. Height	70.81	1.930	in.
2. Weight	163.7	13.50	lb.
3. Surface Area	1.92	0.104	sq. m.
4. Basal R.Q.	.802	0.090	CO_2/O_2
5. Basal Ventilation	2.115	0.556	Cu. ft.
6. Basal O_2 Intake	0.277	0.049	L/min.
7. 100-Yd. Drop-off Swim R.Q.	1.06	0.140	CO_2/O_2
8. 100-Yd. Drop-off Swim Ventilation	2.324	0.484	Cu. ft/min
9. 100-Yd. Drop-off Swim Gross O_2 Intake	2.644	0.505	L/min
10. 100-Yd. Drop-off Swim Net O_2 Intake	2.473	0.513	L/min
11. Net O_2 Intake/Body Weight	0.033	0.007	L/min/kg
12. O_2 Intake/Surface Area	1.279	0.270	L/min/sq.m
13. Gross O_2 Debt	11.817	2.655	L.
14. Net O_2 Debt	6.402	2.238	L.
15. 100-Yd. Drop-off Time	69.4	8.6	sec.
16. Drop-off (Cureton Table)	5.85	2.23	sec.
17. 440-Yd. Swim Time	6:51.2	1:16.6	min./sec.
18. Total Arm Strokes in 100-Yd. Drop-off Swim	93.23	12.86	no.
19. Total Kicks in 100-Yd. Drop-off Swim	254.0	43.90	no.
20. Oxygen Requirement	8.963	2.400	L.
21. Buoyancy Rise in 7′ of Water (Cureton Table)	55.2	12.20	S.S.
22. 24′ Glide	5.8	0.60	sec.
23. Horizontal Floating Capacity (Cureton Table)	63.5	16.0	S.S.
24. Underwater Swim for Distance	126.0	38.9	ft.
25. Underwater Swim for Time	31.98	9.09	sec.
26. Arms Alone, Crawl, 60 ft.	14.71	1.55	sec.
27. Legs Alone, Crawl, 60 ft.	19.94	3.37	sec.
28. Whole Stroke 60 ft.	11.32	1.10	sec.
29. Coordination Index	0.76	1.11	sec.
30. Heartograph Area	0.44	0.17	sq. cm.
31. Heartograph Area/S.A.	0.227	0.085	sq. cm/sq. m
32. Heartograph	21.30	1.88	deg.
33. Heartograph Systolic Amplitude	1.483	0.469	cm.
34. Heartograph Diastolic Amplitude	0.745	0.289	cm.
35. Heartograph Dicrotic Notch Amplitude	0.412	0.194	cm.
36. Heartograph, Amplitude of Diastolic Surge	0.335	0.290	cm.
37. Heartograph, Systolic Time	0.337	0.063	cm.
38. Heartograph, Rest/Work Ratio	1.427	0.478	
39. Heartometer, Systolic Blood Pressure	120.9	14.2	mm. Hg.
40. Heartometer, Diastolic Blood Pressure	50.8	11.1	mm. Hg.
41. Heartometer Pulse Pressure	73.8	20.6	mm. Hg.
42. Pulse Rate, Sitting	68.0	11.6	beats/min
43. Heartograph, Ejection Angle	12.24	4.94	deg.
44. Heartograph, Pulse Wave Cycle	0.796	0.162	cm.
45. Heartograph, Diastolic Time	0.463	0.139	sec.
46. Pulse Rate, 5 Min. after 100-Yd. Drop-off Swim	141.6	14.3	beats/min
47. Heartometer Diastolic Blood Pressure, 5 Min. after 100-Yd. Drop-off Swim	50.8	11.1	mm. Hg.
48. Heartometer Pulse Pressure, 5 Min. after 100-Yd. Drop-off Swim	73.1	15.9	mm. Hg.

Presentation of Data and Discussion

The more pertinent correlations are presented according to test areas. The multiple regression data presented in condensed form were obtained only after repeated multiple regression analyses. The combinations presented were the best found. Since, to some degree at least, this is a trial and error procedure, it is possible better combinations exist than those presented.

After a review of the correlational results for the metabolic variables, the gross oxygen debt and the gross oxygen intake were selected as the metabolic criteria. Swimming performance times for 100-yd. and 440-yd. were included to be the swimming performance criteria. The data are presented according to criteria and test area. The original correlation matrix is not included because of its size.[5] The most pertinent correlations are presented for the reader's inspection.

TABLE 2

Relationship of the Swimming Tests to the Metabolic Criteria[1]

Test	Gross Oxygen Intake	Gross Oxygen Debt
100-Yd. Crawl Drop-Off Time	.355[2]	.448[3]
100-Yd. Drop-Off	.267	.340[2]
440-Yd. Crawl Swim Time	.541[3]	.576[3]
Total Arm Strokes (100-Yd.)	.227	.270
Total Kicks (100-Yd.)	.241	.350[2]
Buoyancy	—.107	.076
24 Ft. Glide Time	.412[3]	.442[3]
Horizontal-Vertical Float	.226	.009
Underwater Distance	.158	.304[2]
Underwater Time	.148	.322[2]
Arms Alone 60 Ft.	.370[2]	.470[3]
Legs Alone 60 Ft.	.466[3]	.480[3]
Whole Stroke 60 Ft.	.127	.232
Co-ordination Index	.259	.443[3]

[1]All correlations listed were computed using the common log values for the oxygen measures.
[2]Significant at the 5% level.
[3]Significant at the 1% level.

TABLE 3

Relationship and Relative Importance of Selected Swimming Tests to the Gross Oxygen Intake

Test	Gross O_2 Intake	100-Yd. Drop-Off	24-Ft. Glide	Arms Alone 60 Ft.	Legs Alone 60 Ft.	B	B^2	Per cent Contribution
100-Yd. Drop-Off	.267	----				.0123	.00015	.10
24-Ft. Glide	.403	.467	----			.2005	.04020	26.70
Arms Alone 60 Ft.	.370	.430	.444	----		.1361	.01852	12.30
Legs Alone 60 Ft.	.466	.339	.480	.461	----	.3028	.09169	60.90
							.15056	100.00

R = .527 ± .411 liters/minute.

[5]1202 correlations are listed in the original correlation matrix with an additional 125 correlations being recomputed using the common log values for the metabolic measures.

TABLE 4

Relationship and Relative Importance of Selected Swimming Tests to the Gross Oxygen Debt

Test	Gross O_2 Debt	100-Yd. Drop-Off	Arms Alone 60 Ft.	Legs Alone 60 Ft.	24-Ft. Glide	Co-ordination Index	B	B^2	Per cent Contribution
100-Yd. Drop-Off	.340	----	----				.0566	.00320	2.30
Arms Alone 60 Ft.	.470	.430	----				.2186	.04778	34.30
Legs Alone 60 Ft.	.480	.339	.461	----			.2267	.05139	36.89
24-Ft. Glide	.442	.467	.444	.480	----		.1685	.02839	20.38
Co-ordination Index	.443	.366	.596	.553	.456	----	.0924	.00854	6.13
								.13930	100.00

R = .588 ± 2.115 liters.

Metabolic Criteria. The arms are of more relative importance to the oxygen debt measure contributing but 12 per cent to the total predictive variance of the measures used in the oxygen intake analysis and 34 per cent in the oxygen debt analysis. The legs are of more relative importance to the oxygen intake measures contributing more than 60 per cent to the total predictive variance of the measures used in the oxygen intake analysis as compared to 36 per cent in the oxygen debt analysis. The trend seems to be for the individuals with the better leg kicks to develop larger oxygen intakes and the individuals with the better arm strokes to be capable of the greater oxygen debts. The trend is just suggested, however, as in these analyses so little of the actual predictive variance is being dealt with—13.9 per cent in the oxygen-debt analysis and 15.1 per cent in the oxygen-intake analysis.

TABLE 5

Relationship of the Cardiovascular Measures to the Swimming Criteria

Measure	Gross Oxygen Intake	Gross Oxygen Debt
Brachial Pulse Wave Measures		
Pulse Wave Area	.471[1]	.412[1]
Pulse Wave Area/Surface Area	.406[1]	.363[2]
Systolic Amplitude	.420[1]	.479[1]
Diastolic Amplitude	.495[1]	.472[1]
Rest/Work Ratio	.108	.429[1]
Pulse Wave Cycle	.318	.280
Diastolic Surge	.277	.428[1]
Ejection Angle	.233	.354[2]
Pulse Rate in 5th Min. of Recovery (Lower pulse rates used as the better measure)	.373[2]	.122
Diastolic Blood Pressure in 5th Min. of Recovery (Lower pressures used as the better measure)	.226	—.273

[1]Significant at the 1% level.
[2]Significant at the 5% level.

TABLE 6

Relationship and Relative Importance of Selected Cardiovascular Measures to the Gross Oxygen Intake

Measure	Gross O_2 Intake	Diast. Amp.	Pulse Rate 5th	Diast. B.P. 5th	B	B^2	Per cent Contribution
Pulse Wave Diast. Amplitude	.495	____			.4385	.19228	79.01
Pulse Rate, 5th Min. Recov.	.373	.424	____		.1809	.03272	13.45
Diastolic Blood Pressure, 5th Min. Recovery	.226	—.149	.046	____	.1355	.01836	7.54
						.24336	100.00

R = .561 ± .401 liters/minute.

TABLE 7

Relationship and Relative Importance of Selected Cardiovascular Measures to the Gross Oxygen Debt

Measure	Gross O_2 Debt	R/W Ratio	Systolic Amplitude	Diast. B.P. 5th	B	B^2	Per cent Contribution
Pulse Wave, Rest/Work Ratio	.429	____			.4265	.18190	33.86
Pulse Wave, Systolic Amplitude	.479	.027	____		.4962	.24621	45.83
Diastolic Blood Pressure, 5th Minute of Recovery	—.273	.033	.087	____	—.3303	.10910	20.31
						.53721	100.00

R = .715 ± 1.828 liters.

TABLE 8

Relation of the Metabolic Variables to 100-Yard and 440-Yard Swimming Performance

Variable	100-Yd. Drop-Off Crawl Swim Times r	100-Yd. Drop-Off Crawl Swim Times r′	440-Yd. Crawl Swim Times r	440-Yd. Crawl Swim Times r′
Basal Respiratory Quotient	.035	.038	.136	.149
Basal Oxygen Intake	.117	.147	.162	.211
100-Yd. Drop-Off Swim R.Q. (Lower time with lower R.Q.)	.173	.060	.216	.105
100-Yd. Drop-Off Swim Ventilation (Corrected)	.154	.035	.059	.009
100-Yd. Drop-Off Swim Gross Oxygen Intake	.323[1]	.355[1]	.353[1]	.541[2]
100-Yd. Drop-Off Swim Net Oxygen Intake	.286	.171	.333[1]	.511[2]
100-Yd. Drop-Off Swim Gross O_2 Intake/Kg. Body Weight	.214	.075	.278	.213
100-Yd. Drop-Off Swim Gross O_2 Intake/Sq.M. Surface Area	.209	.095	.245	.244
Gross Oxygen Debt	.395[1]	.448[2]	.453[2]	.576[2]
Net Oxygen Debt	.340[1]	.324[1]	.342[1]	.315
Oxygen Requirement	.360[1]	.366[1]	.415[2]	.415[2]

[1]Significant at the 5% level.
[2]Significant at the 1% level.
r—Correlations computed using raw scores. r′—Correlations computed using the common log values for the metabolic variables.

The cardiovascular data are difficult to interpret. A large number of analyses were made of these data, the best of which are presented. The only trends evident were: 1. The pulse wave energy measurements[6] are of more relative importance to the oxygen intake. 2. The cardiovascular measures in general, in the present study, relate better with the oxygen debt.

TABLE 9

Relationship and Relative Importance of Selected Metabolic Variables to 100-Yard Drop-Off Crawl Swimming Performance

Variable	100-Yd. Swim Time	Gross O_2 Intake	Gross O_2 Debt	Oxygen Requirement	B	B^2	Per cent Contribution
Gross Oxygen Intake	.355	----	----	----	.2165	.04687	25.64
Gross Oxygen Debt	.448	.380	----		.3687	.13594	74.35
Oxygen Requirement	.366	.408	.764	----	−.0040	.00002	.01
						.18283	100.00

R = .491 ± 7.51 seconds.

TABLE 10

Relationship and Relative Importance of Selected Metabolic Variables to 440-Yard Crawl Swimming Performance

Variable	100-Yd. Swim Time	Gross O_2 Intake	Gross O_2 Debt	Oxygen Requirement	B	B^2	Per cent Contribution
Gross Oxygen Intake	.541	----	----	----	.3826	.14638	40.18
Gross Oxygen Debt	.576	.380	.764		.4647	.21595	59.27
Oxygen Requirement	.415	.408			.0447	.00200	.55
						.36433	100.00

R = .675 ± 56.55 seconds.

Swimming Performance Criteria. The metabolic variables, as collected, are more closely related to 440-yd. performance. The gross oxygen debt is relatively more important to 100-yd. swimming performance, contributing 74.35 per cent of the variance contributed by the three variables. The gross oxygen intake is relatively more important to 440-yd. performance, contributing 40.18 per cent of the variance contributed by the three variables. The gross oxygen intake is relatively more important to 440-yd. performance, contributing 40.18 per cent of the variance contributed by the three variables. These results give some insight into the metabolic adaptation of the power and endurance type athletes (1). The amount of variance contributed by the metabolic variables to the total variance, however, is small, 18.2 per cent of 100-yd. peformance and 36.4 per cent of 440-yd. performance.

[6]The vertical deflections.

The gross oxygen debt, of all the metabolic measures, seems to be the most closely related to all-out swimming performance. Whether the better positive relationships for the oxygen debt were obtained in the present study because the oxygen debt is actually more closely related to swimming performance than all-out treadmill performance or because of the standardized debt collection times in this study, is not known.

TABLE 11

Relation of Swimming Tests to 100-Yard and 440-Yard Crawl Swimming Performances

Variable	100-Yd. Swim Times	440-Yd. Swim Times
100-Yard Drop-Off Crawl Swim Times	—	.773[1]
100-Yard Drop-Off	.690[1]	.500
440-Yard Crawl Swim Times	.773[1]	—
Total Arm Strokes (100-Yd.)	.386[2]	.187
Total Kicks (100-Yd.)	.378[2]	.405[1]
Buoyancy	.235	.275
Twenty-Four Foot Glide Time	.578[1]	.661[1]
Horizontal-Vertical Float	.219	.192
Underwater Swim Distance	.411[1]	.533[1]
Underwater Swim Time	.324[2]	.481[1]
Arms Alone 60-Ft., Time	.594[1]	.519[1]
Legs Alone 60-Ft., Time	.563[1]	.756[1]
Whole Stroke 60-Ft., Time	.557[1]	.560[1]
Co-ordination Index	.346[2]	.397[2]

[1]Significant at the 1% level.
[2]Significant at the 5% level.

Comparison of the 100- and 440-yd. analyses appears to indicate differences in the specific skills or fitnesses required for the events. The best measures of 100-yd. performance were the 100-yd. drop-off and the arms alone and legs alone 60-ft. times. The best measures of 440-yard performance were the legs alone 60-ft. time and the 24-ft. glide. The best single tests were the 100-yd. drop-off, which contributed 59.63 per cent, and the legs alone 60-ft. test, which contributed 69.04 per cent of the amount of the variance contributed by the five tests to 100-yd. and 440-yd. performance respectively.

One could say then that 100-yd. swimming performance is most dependent upon the abilities measured by the 100-yd. drop-off test, or the endurance capacity necessary to maintain the maximum rate of work. The 440-yard swimming performance is most dependent upon the abilities measured by the 60-ft. legs alone test and gliding efficency or upon kicking position and possibly body position in the water. Arm stroking as measured by the arms alone 60-ft. test and the abilities measured by the 100-yd. drop-off test contributed little to 440-yd. swimming performance. The sprint swimmer has a more powerful arm stroke and the ability to maintain the maximum rate of work, whereas the distance swimmer has a relatively poorer arm stroke, better kick, and better gliding efficiency.

TABLE 12

Relationship and Relative Importance of Selected Swimming Tests to 100-Yard Crawl Swimming Performance

Test	100-Yd. Swim Time	24-Ft. Glide	Arms Alone 60 Ft.	Legs Alone 60 Ft.	Drop Off	Under-water Distance	B	B^2	Per cent Contri-bution
24-Ft. Glide	.578	—					.1584	.02509	7.81
Arms Alone 60 Ft.	.594	.411	—				.2264	.05126	15.95
Legs Alone 60 Ft.	.563	.480	.461	—			.2309	.05331	16.59
100-Yard Drop-Off	.690	.467	.430	.339	—		.4377	.18158	59.63
Underwater Distance	.411	.486	.329	.424	351	—	.0080	.00006	.02
								.32130	100.00

R = .813 ± 5.02 seconds.

TABLE 13

Relationship and Relative Importance of Selected Swimming Tests to 440-Yard Crawl Swimming Performance

Test	440-Yd. Swim Time	24-Ft. Glide	Arms Alone 60 Ft.	Legs Alone 60 Ft.	Under-water Distance	Drop Off	B	B^2	Per cent Contri-bution
24-Ft. Glide	.661	—					.2877	.08277	22.92
Arms Alone 60-Ft.	.519	.444	—				.0904	.00817	2.26
Legs Alone 60-Ft.	.756	.480	.461	—			.4993	.24930	69.04
Underwater Distance	.533	.486	.329	.424	—		.1283	.01646	4.56
100-Yard Drop-Off	.454	.467	.430	.339	.351	—	.0664	.00441	1.22
								.36111	100.00

R = .844 ± 41.11 seconds.

TABLE 14

Relationship and Relative Importance of the Best Selected Measures to 100-Yard Crawl Swimming Performance

Measure	100-Yd. Swim Time	100-Yd. Drop Off	Arms Alone 60 Ft.	Legs Alone 60 Ft.	Gross O_2 Debt	Gross O_2 Intake	Systolic Blood Pressure	Pulse Wave Cycle	B	B^2	Per cent Contribution
100-Yd. Drop-Off	.690	___							.5200	.27040	58.20
Arms Alone 60 Ft.	.594	.430	___						.2896	.08387	18.05
Legs Alone 60 Ft.	.563	.339	.461	___					.3067	.09406	20.25
Gross O_2 Debt	.448	.340	.470	.480	___				.0152	.00023	.05
Gross O_2 Intake	.355	.267	.370	.466	.380	___			—.0148	.00022	.05
Quiet Systolic B.P.	.372	.446	.394	.424	.146	.158	___		—.1042	.01086	2.34
Pulse Wave Cycle	.325	.313	.476	.316	.239	.228	.092	___	—.0702	.00493	1.06
										.46457	100.00

R = .815 ± 4.99 seconds.

TABLE 15

Relationship and Relative Importance of the Best Selected Measures to 440-Yard Crawl Swimming Performance

Measure	440-Yd. Swim Time	24-Ft. Glide	Legs Alone 60 Ft.	Arms Alone 60 Ft.	Gross O_2 Intake	Gross O_2 Debt	Pulse Wave Cycle	Systolic Blood Pressure	B	B^2	Per cent Contribution
24-Ft. Glide	.661	___							.3169	.10043	25.82
Legs Alone 60 Ft.	.756	.480	___						.4185	.23184	59.61
Arms Alone 60 Ft.	.519	.444	.461	___					.0457	.00209	.54
Gross O_2 Intake	.541	.412	.466	.370	___				.1127	.01270	3.27
Gross O_2 Debt	.576	.442	.480	.470	.380	___			.1412	.01721	4.42
Pulse Wave Cycle	.403	.237	.316	.476	.228	.239	___		.1067	.01138	2.93
Quiet Syst. B.P.	.256	.321	.424	.394	.158	.146	.092	___	.1153	.01329	3.41
										.38894	100.00

R = .865 ± 38.45 seconds.

The data presented in Tables 14 and 15 show the swimming test items, the 100-yd. drop-off, arms alone 60 ft. and the legs alone 60 ft. to be the best items of swimming performance. The metabolic and cardiovascular items, determined by the earlier multiple regression analyses to be the most representative items in their respective areas, when summed produced less than 10 per cent of the contribution to the predictive variance of the combined seven tests.

The weightings in the 100-yd. analysis indicate the importance of good mechanics in the arm and leg strokes and emphasize the value of the diagnostic swimming tests, particularly the 100-yd. drop-off test. The test reflects the swimmer's ability to maintain the maximum speed throughout the event or the ability to maintain a high work rate for a relatively short period of time. A high relationship was anticipated between the 100-yd. drop-off test and the gross oxygen debt but this did not materialize. The original data were complicated by curvilinearity which lowered this relationship ($r = .264 \pm .099$). When the common log values for the gross oxygen debt were used, the portion of the data dealing with the better swimmers assumed linear form and the correlation rose to $.340 \pm .093$, significant at the 5 per cent level. The attenuation in the poorer portion of the data, however, was not corrected. These results seem to indicate the drop-off relates well with the gross oxygen debt in good swimmers, but that it is unreliable with the poorer performers.

The data presented in Table 15 show the swimming test items, legs alone 60 ft. and the 24-ft. glide to be the best test items of 440-yd. swimming performance when combined with the best test items from the metabolic and cardiovascular areas. The best metabolic and cardiovascular tests, when summed, produced less than a 15 per cent contribution to the total predictive variance for the combined test items. The weightings obtained in this analysis again reflect the importance of kicking efficiency and gliding ability to 440-yd. swimming performance.

The role of the abilities tested by the metabolic variables, in the final analyses when combined with the swimming and cardiovascular areas, is not clear, though it can be stated the abilities are more important to 440-than 100-yd. performance. An inter-relationship between the testing areas was expected but on the basis of earlier work it was not expected to be high.[7] In the final multiple regression analyses, however, *the diagnostic swimming tests completely dominate the relative contribution figures with better than 85 per cent of the total predictive variance in both analyses.*

The swimming tests in this sample reflect metabolic and cardiovascular fitnesses, in addition to the swimming skills. The gross oxygen debt and intake correlated (R) $.491 \pm 7.51$ sec. with the 100-yd. crawl time, yet in the final multiple regression analysis yielded a total relative contribution of only .10

[7]The drop-off test excepted.

per cent. The gross oxygen intake and debt correlated (R) .675 ± 56.55 sec. with 440-yd. crawl swim times, yet in the final multiple regression analysis yielded a total relative contribution of only 7.69 per cent. The 24-ft. glide and the legs alone 60 ft. measures combined correlated .826 ± 42.90 sec. with 440-yd. performance. With the addition of the best metabolic and cardiovascular measures, the multiple R improved only .039 to .865 ± 38.45 sec.

Conclusions

1. The abilities measured by the previously established *Cureton Diagnostic Swimming Tests* are relatively more important to 100-yd. and 440-yd. swimming performance than the capacities measured by the cardiovascular and metabolic tests.

2. The capacities measured by the gross oxygen debt and the 100-yd. drop-off test are of more relative importance to 100-yd. than 440-yd. swimming performance.

3. The capacities measured by the gross oxygen intake and the legs alone 60-ft. test and 24-ft. glide time swimming tests are of more relative importance to 440-yd. than 100-yd. swimming performance.

4. The metabolic, cardiovascular and swimming tests in combination relate better generally to 440-yd. than 100-yd. swimming performance.

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(Submitted 8/7/54)

Group Movement and Growth in a Physical Education Class[1]

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Abstract

In this study, an effort was made to identify group change and development in the physical education class through observation and recording, sociometric tests, and the Dimock's Best Friends Test, and to analyze the effectiveness of these techniques as possible tools for the teacher. Group movement and growth in the physical education situation were identified by all three devices. Since the keeping of detailed recordings of daily observations and the subjective judgment required in their analysis are inefficient and impractical for the teacher, sociometric tests, based on the results of this investigation, are simplest to administer to indicate changes and growth, and are most productive of meaningful results for the teacher.

SINCE IN PHYSICAL education a child moves, sees, thinks, and feels at once in situations of social and democratic importance (2, *p. 1*), the physical education group is one type of optimum relationship in which to study and observe growth and development. Tests and measurements have indicated individual physical improvement as a result of the physical education program, and some research in the field has demonstrated mental development but, owing to inadequate tools or methods of research, little scientific experimentation has been made to prove professional claims or ascertain achievement of stated goals that participation in physical education contributes to the personal-social growth and development of participants.

Extensive research disclosed three available valid devices suitable for objectively indicating personal-social changes in the group situation. Several physical education research studies have utilized sociometric tests (8, 9, 20) to show objective relationships between physical education and the development of groups, and the individuals constituting those groups (2, 12, 16), and the Dimock Best Friends Test has also been employed to a great extent in social agencies to determine members movement toward group cohesion.

The group study method, which is a case study of a group through careful and systematic observation and detailed recording and interview, has been used extensively by social group workers to study and analyze groups. *The Adolescent in Social Groups* by Frances Burks Newman (13) was a long-range group study of an adolescent group pointing out individual growth and movement through group experiences. Gisela Konopka in *Therapeutic Group Work with Children* (10) depicts personality and social growth of individuals. She uses

[1]This study was made in partial fulfillment of the requirements for the degree Master of Science in Physical Education, University of California, Los Angeles, 1952.

the narrative records of her observations of the group as the method by which to verify group and individual growth. Wilson and Ryland (19) include several group studies in their book, and Grace Coyle relates group studies of five groups through the use of observation and recording in Studies in Group Behavior (5). Although Stwalley has made "Case Studies of Five 'Isolated' Individuals in an Elective Dance Class of Eleventh and Twelfth Grade Girls" (17), no group studies were discovered in the research of the physical education profession.

The Problem

An effort was made in this study to indicate and analyze personal-social group growth for one semester in a physical education class consisting of 30 high school girls. To point out a new method of research for physical educators, the researcher experimented with the group study method. The purpose of this study, therefore, was: 1. To discover if group change in the physical education class can be identified through the use of observation and recording, sociometric tests and the Dimock's Best Friends Test; and 2. To determine if the results of techniques were essentially consistent and which was the simplest and most productive of meaningful results.

Procedure

The study class was organized and conducted in the most democratic manner possible while adhering to administrative policies in the particular school situation. Essentials of this democratic type program included planning by the girls, a program based on needs and interests, individual and group evaluation, student leadership where possible, individual responsibility to the group, and an endeavor on the part of the teacher to play a supporting and guiding role rather than being authoritative and absolute. Data acquired from school cumulative records, student questionnaires and personal interviews, as well as that accumulated through the three main techniques of this study—observation and recording, sociometric tests and Dimock's Best Friends Test—were utilized throughout to enable the teacher to better understand individual and group needs and to stimulate democratic group process.

Observation and Recording. The essential data-gathering tools—observation and recording—were utilized daily and were under the partial supervision of two social workers. Although the complete written records of the daily observations made in this class represented only a partial sampling of the students' total behavior, it was an accurate recital of all action taking place in the study group.

The form followed to record the daily observations which constituted the basic data for analysis and interpretation in the investigation was as follows (7, 14, 15, 19):

1. Names of members present and absent.
2. Record of contact and interviews held with members since last class meeting.
3. Process recording of the group session—who came first? who came with whom? how did what happen to whom? who proposed what? what decisions were made? what

was the relation of the teacher to the interaction? (All this information was recorded in terms of the program content of the session.)

4. Analyses of the group experiences of this session—what did the interaction reveal? what were the sub-groupings? what conflicts occurred? what insights into the interests and needs of the total group and the individual members were gained?

5. Summary of the teacher's understanding and knowledge of members with baffling behavior.

6. Comment on program content, group movement, group atmosphere, and an evaluation of the teacher's part in the activity.

7. Plans for preparation for next class.

After accumulating all of the daily data in the narrative process record in accordance with the preceding outline, the investigator had no means or indices by which to indicate objectively any group change. A survey of the literature in social group work showed that, in general, ten criteria for a good group were agreed upon by Grace Coyle (3, 4, 5), Hedley Dimock (6), Harleigh Trecker (18), and Gertrude Wilson and Gladys Ryland (19), authoritative sources in the field of social group work; these were adopted to use as a standard of comparison in this investigation:

Criterion One: A good group develops a purpose. A pattern of individual acceptance or rejection forms about this purpose.

Criterion Two: The program of a good group grows out of the needs and interests of members rather than being super-imposed. It is a good group when members propose, plan, carry out and evaluate their own program experiences with the assistance of the leader or teacher.

Criterion Three: A good group adopts a pattern of structural relationships around its members. It is a self-governing unit with indigenous leadership.

Criterion Four: There is corporate action in a good group resulting from a conflict and then agreement within the group through one or another type of adjustment to the conflict.

Criterion Five: A good group works with a wide range of participation; all participate to the best of their ability.

Criterion Six: There is group loyalty which results in "esprit de corps" in a good group.

Criterion Seven: A good group is cohesive.

Criterion Eight: A permissive emotional climate and atmosphere is characteristic of a good group. One of the aids to fruitful personal relations lies in a warm, friendly and accepting atmosphere. In such a climate, the powers of each individual can more easily expand and become socially valuable by contributions to the whole. Therefore, individuals achieve personal and social satisfaction and goals through a good group.

Criterion Nine: A good group accepts the guidance and counseling of the teacher who has developed an efficient working relationship with members of the group.

Criterion Ten: A good group is on-going and replaces its membership.

The primary analytical process of the study was an examination of the narrative process record in contrast to the criteria for a good group. The written occurrences of the record pertaining to a specific criterion were isolated and listed chronologically under that criterion. If the data showed that the class had moved toward or attained additional or better characteristics of that specific criterion during the course of the semester, or if data indicated that the group had developed in direct contrast to the criterion, this was accepted as an indication of group change. When the group remained static over the course of the semester by comparison to a criterion, it was assumed that change or growth did not occur in that instance.

Sociometric Tests. A series of sociometric tests, which discover group structure and individual status or roles within the group, were administered at the formation of the class, the mid-point and the last day as another technique to test for ability to show personal-social changes in a physical education class. Members of the group were asked, "What two members of this class would you like most as team mates?" (8, p. 16).

By charting group members' names with lines pointing to first and second choices, sociograms were constructed for each test as shown in Figures I, II, and III of the findings, presenting a visual pattern of the class structure—its isolates or fringers, natural leaders and spheres of influence, and any transitions in structure occurring over the course of the semester.

The Dimock Best Friends Test. Dimock's test (6, *p. 176*) to determine the amount of cohesiveness in a group was administered at mid-semester and at the conclusion of the experimental period. In his test, each member of a group lists the names of his ten best friends in order of preference; these choices are not confined to the specific group's membership. A numerical score is determined by first adding the total points of each individual's choices of members in the group, ten points being awarded for each first place choice of a group member, nine for second, and so on. There is a possibility of 55 points for each individual, if all his ten choices are members of the group. Fifty-five points multiplied by the total number in the group is the possible score of the group (55 times 30 equaling 1,650 in this group). The sum of all the individual scores equals the actual score. The actual score is then divided by the possible score and the resulting answer is the friendship index of a group's cohesiveness. The friendship index represents the extent to which a particular group is made up of individuals who are friends of one another.

Findings

Through an analysis and interpretation of the data uncovered by the group study method in comparison with the ten criteria for a good group, it was in general possible to identify group movement. An analysis of the group's activity throughout the semester, comparing beginning and ending characteristics, showed movement or change in most instances. For example, data in the record pertaining to Criteria One, Two, and Ten are described very briefly as follows to give a concrete illustration of how movement was identified in the process records:[2]

Criterion One—At the first class meeting of the semester 20 of the 30 members stated that their main purpose was "to have fun"; eight wanted "to learn to play better"; one wanted to make friends; and one wanted "to exercise for a better figure." The major portion of the group, therefore, had a common purpose at the outset of the semester. A study of the total record indicated that group members worked and moved toward the attainment of this purpose.

[2]Mimeographed examples of two actual days narrative process recording of the study class can be obtained by writing to the author.

Movement was also shown in the solidifying of one common purpose. At the end of the term, all members stated that fun had been their main objective in the group, but that learning to play better had also been important since this contributed to fun.

A pattern of individual acceptance and rejection formed about the primary and secondary group purposes. Girls who contributed most to the fun were most popular, as evidenced by being chosen as squad leaders and captains and by receiving the greatest number of choices on sociometric tests, as Ger, Mol, Mar, Mad, and Dee. Skilled players also moved toward leadership roles. Kay, on Chart I, received only one choice; by the end of the semester, she received more choices than anyone. Kay was a very skilled athlete who was not well known at the beginning of the class. Individuals or sub-groups that detracted from the fun and/or who played poorly were rejected or isolated; Lou, Pat and Sar, and Bet and She are examples of this on the sociograms. Isolated individuals and sub-groups making an endeavor to play or contribute to the fun were accepted by the group as the semester progressed. Evidence in both the process record and the sociograms can be found to show this.

In regards to Criterion Two, the program of this group was formulated on its needs, as interpreted by the teacher, and based on the stated interests of its members. The activity content of the program, as well as some of the routine organizational procedure, was planned by the group with guidance from the teacher.

On the preference lists written the first day of class, the majority favored playing volleyball and softball. One socially unaccepted sub-group wanted to participate in badminton. After much discussion, the group decided first to play team volleyball; second, to learn how to play volleyball doubles; and third, to conclude the semester with softball. No arrangement was made to include badminton at this time. Later in the semester, the group changed its plans to permit this activity which was a need and an interest of the specific isolated sub-group. Through playing badminton together—and having fun—the sub-group became accepted by the entire group. This process of acceptance does not show up on the sociograms, possibly due to the small number of choices pictured there; but concrete evidence exists in the record, showing group leaders playing, talking, and sharing with this formerly isolated group.

A contemplation of the material in the record gives evidence that the group's ability to propose, plan, and carry out its own program experiences increased as the semester progressed. The group's trials and tribulations in planning and carrying out their activities showed movement. The group may not have grown toward this criterion quantitatively—by making a greater number of plans—but it did grow qualitatively—in skill. Many members who were inexperienced in democratic planning developed a degree of skill and learned to accept responsibility to the group by the end of the semester.

The group failed to evaluate its experiences fully because the teacher did not provide adequate time for this important aspect of group development. Group evaluation was held twice only during the semester; at the mid-semester point, an evaluation was made of what had been done previously in class; the second time, group evaluation was held after the final activity of the semester—an entirely student-proposed, -planned and -executed softball playday. At this evaluation period, the group learned many valuable lessons relating to the planning of playdays. Since much can be learned through the sharing of group experiences in evaluation, the teacher could have used this tool to greater advantage in helping the group to move and grow. There was, therefore, little movement toward this aspect of Criterion Two—evaluation of program experiences.

There is evidence depicting a need for weaning from the teacher; at times, she was too supporting to the group and individual members. This could indicate some movement away from Criterion Two.

The group did not move in regard to Criterion Ten, for it was not an on-going group and its existence necessarily ended with the completion of the school term. Since it was a class, there was no selection or replacement of members.

Sociometric Tests. Sociograms constructed from the sociometric tests, delineated on Figures I, II, and III, showed movement and change at the three testing points of the semester.

Figure I shows (using fictitious names):

Mutual primary choices: Dee and Marg; Lupe and Ann; Lou and Sar; Mol and Lee; Bet W and Mary; Bet K and She.

Mutual secondary choices: Mol and Dee; Marg and Viv; Bet K and Meta; Lupe and Dodo.

Combination choices: Mar and Mad; Ger and Mar; She and Meta; Dodo and Ann; Kay and Jo.

Islands: Lupe, Dodo and Ann; Bet K, She, and Meta.

Stars: Dee is the predominant star with 10 choices; Ger, five; Marg, five; Mol and Mar, four; Mad, three.

Isolates: Bet B, Sal S, Sal T, Val, Barb, and Cath.

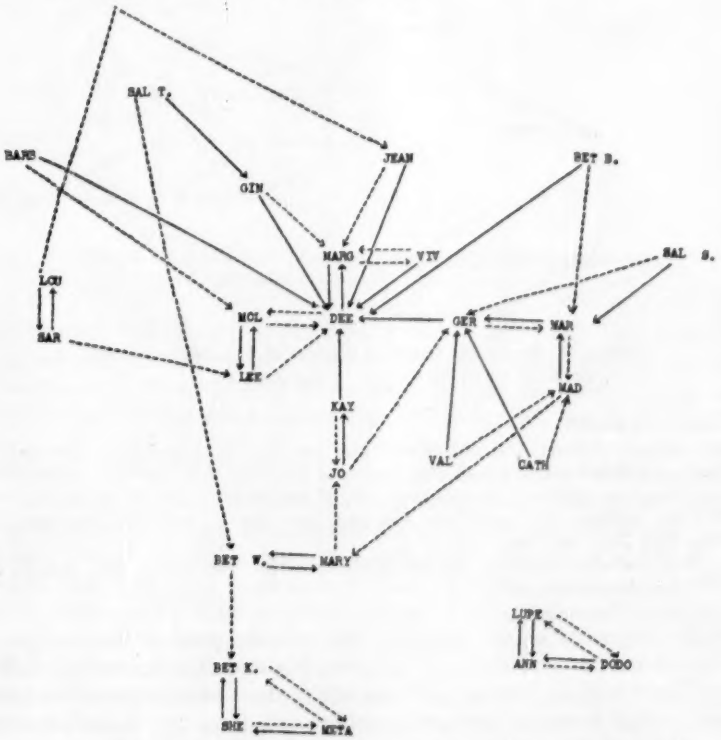

FIGURE I. Sociogram Denoting Choices of Teammates, January.
Legend: 1st choice ———; 2nd choice .....

Figure II shows:

Mutual primary choices: Dee and Marg; Mad and Mar; Jane and Mol; Bet W and Mary.

Mutual secondary choices: Gin and Bet B; Jane and Lee.

Combination choices: Gin and Barb; Dee and Viv; Mol and Lee; Kay and Ger; Mar and Ger; Pat and Lou; Lou and Sar.
Islands: Mol, Jane, and Lee.
Stars: Viv has the most choices, five; Dee, Ger, Mad, Mary, Kay have four; Mar, Mol, Cath have three.
Isolates: Jean, Sal T, Sal S, Ann, and She.

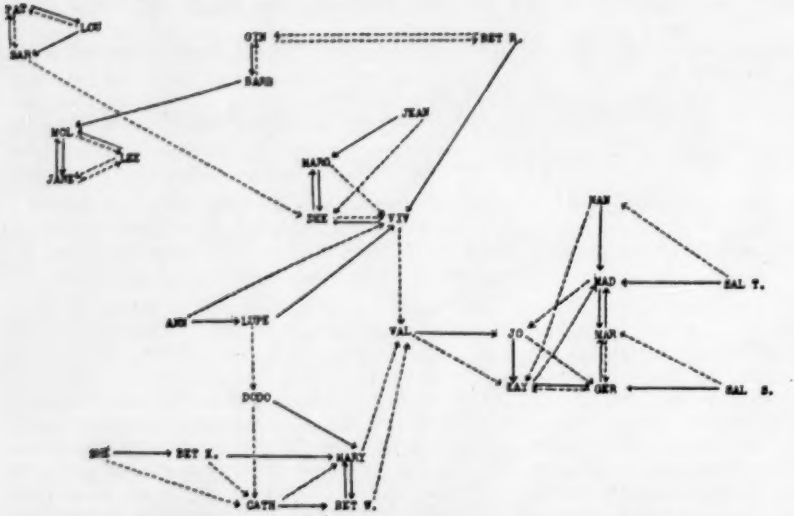

FIGURE II. Sociogram Denoting Choices of Teammates, March.
Legend: 1st choice ————; 2nd choice _____.

Figure III shows:
Mutual primary choices: Dee and Marg; Lou and Sar; Jane and Mol; Kay and Jo; Cath and Bet W; Bet K and She, Nan, and Sal T.
Mutual secondary choices: Lee and Jane; Bet W and Mary.
Combination choices: Pat and Lou; Mol and Lee; Bet B. and Dee; Ger and Kay.
Islands: Mol, Jane, and Lee.
Stars: Kay has seven choices; Dee and Mol, four; Ger, Viv, Marg, Cath, Bet W, Lou and Jane have three.
Isolates: Barb, Lupe, Jean.

At the beginning of the semester, Dee was the predominant indigenous leader with ten choices; Marg and Ger, five, Mol and Mar had four, and Mad, three. There were six isolates—girls no one chose. The structure of the group showed a high degree of inter-relationships and a number of mutual attractions. Although the majority of the group was related to or revolved about Dee, there were two completely isolated sub-groups.

By the middle of the semester, formation of a number of compact subgroups had become more pronounced—Mol, Lee, and Jane; Marg, Dee, and Viv with Jean tagging on as an isolate; Bet W, Cath, Mary, and Dodo with Bet K and She fringing; Pat, Lou, and Sar; and a large sub-group containing

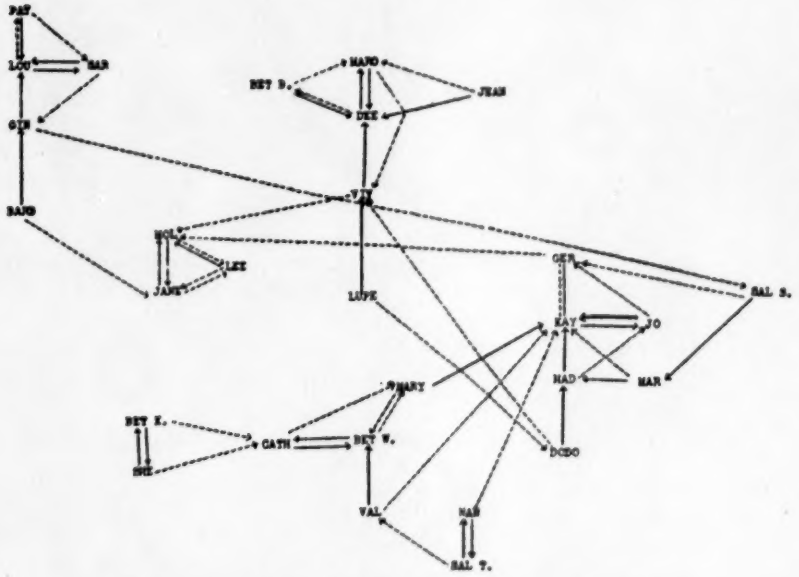

FIGURE III. Sociogram Denoting Choices of Teammates, June.
Legend: 1st choice ————; 2nd choice .....

Mad, Kay, Jo, and Ger and isolates Sal T, Sal S, and Nan. This latter sub-group had been part of the main sub-group with Dee as the center of attraction in Sociogram 1. Now the only relationship between the newly formed sub-group and Dee's clique was a single choice of Viv for Val, and Val's attraction to Jo.

Although Viv had the greatest number of votes—five—on Sociogram 2, there seemed to be no one definite star but rather individual leaders of sub-groups who received votes from isolates fringing the specific sub-group. Dee had four votes in her sub-group along with Viv's five; Mary had four, and Mol and Cath had three votes each in their respective sub-cliques, while in the largest group Ger, Mad, and Kay each had four and Mar had three votes. The largeness of this latter sub-group probably accounted for three girls, more or less, sharing a leadership position.

Evidence in the process record depicting Dee as an aggressive, over-dominant, and bossy individual who had begun to irritate the group by mid-semester possibly explains the reason for her loss of choices at that point. She was an excellent player and everyone recognized her ability, but group members grew to resist her domination. There were four isolates at this time—Annie and Jean had become isolates, while Bet B, Val, Cath, and Barb had become accepted by some members of the group. In fact, Cath had become an integral part of one sub-group. Sal S and Sal T remained isolated.

Throughout, isolates are in part, perhaps, determined by cutting the choices shown on the sociograms to two for the sake of simplicity and clarity.

The group retained the fundamental grouping pattern pictured on Sociogram 2 at the end of the semester (Sociogram 3) with Ger, Kay, Jo, Mar, and Mad forming the largest sub-group; Pat, Lou and Sar adding Gin to their clique; Cath, Bet W, and Mary dropping Dodo and becoming a tighter sub-group; Bet K and She, who had varied in structure on the second sociogram, choosing each other on Sociogram 3 and resuming an isolated position; Mol, Lee, and Jane remaining isolated; and Mar and Dee adding Bet B while Viv became less important. There was no predominant leader, although Kay now had the most choices; Dee and Mol retained a leadership role within their area of influence with four votes each; Ger, Viv, Marg, Cath, Bet W, Lou, and Jane each received three votes; Jean remained an isolate while Barb and Lupe assumed this role. Sal S gained one choice, and Sal T and Nan, former isolates, chose one another.

Although there are no significant changes in the structure in Figures II and III, sociograms in the original study, depicting a greater number of choices (five), showed the group divided rather effectively into two camps at mid-semester, and at the conclusion of the semester, there was a change to more homogeneous and closely-knit sub-groups.

Definite movement can be seen in these figures by (1) Dee's loss of the predominant leadership role (from ten votes she dropped to four and remained with four choices); (2) changes in mutual attraction (only three mutual attractions remained consistent throughout the group); (3) formation of small, closer-knit sub-groups; (4) loss of or gaining the isolate role; and (5) variation in leadership roles. No change can be seen in several fundamental groupings, however, as Lou and Sar, who remained static throughout although Pat was added to this group; Bet W and Mar remained static, adding Cath; Dee and Marg were mutual choices throughout although the remaining constituents of the clique varied; Mar chose Dee and Viv on each sociometric test. Mol and Lee chose one another at each testing point, although Jean was added and surplanted Lee as Mol's first choice in Sociograms 2 and 3. Mar always chose Mad but her second choice varied. Sal S chose Ger and Mar consistently, and the fringer Jean chose the same two—Dee and Marg—on each test.

The isolate role shifted constantly, although Sal S and Sal T remained isolates on the first two sociograms and Jean, on the last two. Kay changed from an individual with one choice to four to receiving the most (seven) on Sociogram 3. Bet B was an isolate, then received one vote and was finally accepted in Dee's sub-group. Cath was an isolate on the first sociogram, receiving no choices, and then gained three on the last two sociograms after becoming an accepted member of a clique. These are but a few examples of the indications of change discovered by using sociometric tests in this investigation.

Dimock's Best Friends Test. Concrete evidence of change was obtained by using the Dimock's Best Friends Test. From a statistical viewpoint this group appeared to be a highly cohesive group within the framework of reference for this situation. There was a possible score of 1,430 (26 girls present in class times 55 total possible points) and an actual score of 628 points at mid-semester giving a friendship index of 43.9. The average friendship index for groups having special interests is 32; the range is 16-50. The range for Scout and Hi-Y groups is 31-61 and 45 is their average friendship index. These are usually highly cohesive groups, and the group under investigation in this study had cohesion equal to the type usually found in Scout or Hi-Y groups.

On the second Dimock test, there was a possible score of 1,375 (25 members present times 55) and an actual score of 668 points. This made the friendship index 48.5 making almost a five-point increase over the result of the first test. This indicates definite growth and movement toward cohesion. This growth appeared to be accompanied by a greater solidarity into sub-groups as reflected by the sociograms. The implication may be that the face-to-face relationship in small sub-groups drew class members together cohesively or stimulated greater friendships than the relationships in larger cliques.

Analysis of Method and Techniques

Through this investigation varying evidence was accummulated to show that personal-social change occur in a physical education class. How to determine the quality of growth, either negative or positive, or the quantity remains unknown. However, certain conclusions and implications can be drawn concerning the research instruments utilized in this experiment, which was mainly devoted to the analysis of the method and its accompanying techniques.

First, the group study method gives evidence of growth because in the records of observation movement toward or away from the criteria for a good group can be found. Material showing changes and development in individuals is also present in the process record. As a research method in physical education, the group study method has unexplored possibilities, but the amount of time involved in keeping accurate narrative process records of daily observations makes this method of indicating group growth and movement impractical and inefficient for use of the physical education teacher.

Analysis and interpretation of process record material is also highly subjective in instances and requires an objective standard of comparison. The criteria for a good group used for comparative purposes in this investigation were unrealistic within the school situation. These criteria are only wholly realistic of attainment in a voluntary and spontaneous group; differences between a group in physical education and in the voluntary setting of a social agency are: compelled to attend the class; the teacher holds an authoritative position; students must wear a uniform, usually not of their own choosing; the group meets in the formal setting of the school; time limit set to the length of the class; the group is set-up, not spontaneous, according to cur-

riculum needs; no choice of group members; certain program requirements must usually be met.

Secondly, sociograms revealed evidence of group structure changes and of changes in the personal-social roles of individuals during the semester. The Dimock Best Friends Test also showed movement toward cohesion in the group after a semester in a physical education class where democratic procedure was used. These tests do not appear to produce equivalent results for Dimock's Test shows group cohesiveness insofar as members of a group are friends of one another, while the sociometric tests visually represent class structure and individual relationships at check points in group development.

Together the sociometric and best friends are equivalent to a sizable portion of the material in the process record. The comparative simplicity of administering and compiling sociometric tests and the Dimock test recommends their use to the teacher. Certainly, both tests can give the teacher an adequate picture of her group, group movement, and the effect of her teaching methods, although not as extensively as the use of observation and recording.

From the information of this study, sociometric tests with their resulting sociograms are the simplest techniques to administer which will indicate movement and change, and produce the best and most efficient results for the teacher. It is suggested, however, that five choices be asked and used when drawing the sociograms. The Dimock test, while simple to administer, supplies data of only one type and is not as productive of meaningful results as the sociometric tests.

Summary

This investigation indicated that group movement and growth take place in the physical education class as shown in establishing and carrying on a democratic program; in working toward group goals; in the formation of sub-groups; and in the inter-action with others.

Although the teacher does not have the time to sit down after each class and compile extensive narrative process records, the group study method entailing observation and recording is an excellent method of research to utilize in exploring human behavior in the class situation because:

1. Evidence of individual and group movement and growth can be traced in the recorded observations.
2. The structure and functioning of groups are depicted in records of class observation.
3. The function of individual roles within the group is revealed in the record as in the group's effect on the individual.
4. Individual and group weaknesses and problems can be found through analyzing the record.
5. Observation and recording help the teacher to analyze her own role in the group and to develop insight into individual and group behavior.

The set of ten criteria used to estimate the group's development in the process record, although unrealistic in the school situation, is one type of

standard for comparing movement and growth which could prove useful to professional personnel. Both the sociometric and Dimock Best Friends tests can be used by the teacher to show class changes. The sociometric tests, however, appear to be more efficient, productive, and meaningful.

Since the investigation of human behavior, either individually or in groups, is dependent on subjective or inadequate techniques in most instances, findings derived in the research of human groups do not always appear to have the same validity and reliability as those discovered in factual and physical scientific studies. Further experimentation of existing and new social scientific techniques, such as attempted in this study, is needed in physical education.

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(Submitted 5/25/53)

A Softball Knowledge Test

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Abstract

In this study an instrument was constructed and evaluated for determining the extent of knowledge and the marking of college students. Statistical analysis of the test consisted of an odd-even reliability coefficient; and the item analysis of difficulty rating and the index of discrimination. A norm table and T-Scores are presented. The test, consisting of 60 true-false items, 25 completion, 5 fair or foul ball, and 10 the ball is in play or dead, is appended.

THE TEST USED in this study (see Appendix, page 237) to measure the extent of an individual's knowledge of softball has been in use for several semesters. It has served as a final examination in determining the extent of knowledge and the grading of the students in the Required Physical Education Program at the University of Florida.

Softball was taught for seven and a half weeks, with two full hour periods of class time per week.

The softball course was taught from a prepared syllabus by means of lectures, demonstrations, practice, and criticism. Each member of the class was given a copy of the official softball rules. This paper is concerned only with an evaluation of the softball knowledge test.

Procedure

A written examination was prepared by the chairman for the softball course and presented to three instructors and 15 students for critical analysis. Based on their evaluation of the items, the test was revised.

This test in its revised form was used by three instructors in four classes totaling 116 students and was administered during the last class period. The test was then subjected to item analysis. If the difficulty rating was not between 10 and 90, or the index of discrimination was not 20 or more, the item was revised.

The second revision of the test (Appendix) was used by three other instructors in four classes totaling 115 students. The test was administered during the last class period.

The tests were subjected to item analysis and the results are presented in the Appendix.

Reliability

The odd-even reliability coefficient for the first revision of the test based on the 116 cases was .71, and the prophesied reliability for the whole test by the Spearman-Brown Formula was .83.

The odd-even reliability coefficient for the second revision of the test based on 115 cases was .64, and the prophesied reliability for the whole test by the Spearman-Brown Formula was .78.

Item Analysis

The value of the individual items was determined by two types of analysis:

1. *Difficulty Rating.* The difficulty rating of the individual items was obtained by dividing the number of correct responses by the number who took the test. Thus, the lower the difficulty rating, the more difficult the item. Ideally, the ratings should range from 10 to 90. The difficulty ratings are presented in the first column of the Appendix.

2. *Index of Discrimination.* The index of discrimination for the individual items was obtained by computing the percentage of the "highs" and "lows" who answered the item correctly. The upper 27 per cent of the scores were the "higher"; the lower 27 per cent of the scores were the "lows." The percentages were then translated into the index of discrimination by means of the table developed by Flanagan (2). Ideally, the index should be 20 or higher. The indexes of discrimination are presented in the second column of the Appendix.

Norm Tables

The mean score was 61.80 for the softball knowledge test based on the 115 men tested, with a range of scores from 8 to 89 and a standard deviation of 13.60.

Table 1 gives the assignment of marks based on the standard deviation technique (3).

TABLE 1

Assigning Letter Marks for Softball Knowledge Test Scores

Letter	*Scores*
A	83-up
B	70-82
C	55-69
D	41-54
E	40-down

In order to combine the softball knowledge test scores with other scores to arrive at a final mark, T-scale scores (9) were established for the group of 115 students, Table 2.

TABLE 2

T-Scores for Softball Knowledge Test

Scores	T-Scores	Scores	T-Scores
89	76	60	48
88	69	59	48
87	68	58	47
86	68	57	46
		56	46
85	66		
84	65	55	45
83	65	54	44
82	65	53	43
81	64	52	42
		51	40
80	63		
79	62	50	39
78	61	49	39
77	60	48	38
76	60	47	37
		46	36
75	59		
74	58	45	36
73	57	44	35
72	57	43	34
71	56	42	34
		41	33
70	56		
69	55	38	32
68	54		
67	53	31	30
66	52		
		14	28
65	52		
64	51	8	24
63	50		
62	50		
61	49		

Summary

1. An objective test consisting of 60 true-false questions, 25 completions, five fair or foul questions, and ten ball-in-play or dead ball situations.

2. The reliability of the first revision of the test was .83.

3. The reliability of the second revision of the test was .78.

4. The difficulty rating and the index of discrimination are presented.

5. Norm table and T-scales are presented for the knowledge test.

6. Certain test items which do not measure up to item analysis standards on the basis of difficulty rating and/or index of discrimination need revision.

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APPENDIX

Softball Examination

Part No. 1: If the statement is true, encircle the "T" on the answer sheet. If the statement is false, encircle the "F" on the answer sheet. *Do not guess. Scoring R—W.*

Difficulty Rating[1]	Index of Discrimination[2]	Answer	No.	Statement
99	30	F	1.	The distance between bases is 90 feet and the base runners must touch each of these bases in consecutive order.
61	20	F	2.	In the history of softball the distance between home plate and the pitcher's rubber has always remained at 46 feet.
83	35	F	3.	With a runner on first, the pitcher throws the ball to the batter for a called illegal pitch, the man on first attempts to steal second on the pitch but is thrown out by the catcher. The man going to second is out and the batter has one ball called against him.
99	30	F	4.	The batter has no designated area in which to stand while receiving a pitch from the pitcher.

[1]The lower the rating, the more difficult the question.
[2]The higher the index, the more discriminatory the question.

Difficulty Rating	Index of Discrimination	Answer	No.	Statement
54	42	F	5.	When preparing to throw a softball, always hold the ball between the thumb and first two fingers of the throwing hand.
91	48	T	6.	In an attempt to execute the "do or die" (suicide) squeeze play, the runner on third base breaks for home with the pitch.
80	20	T	7.	On an illegal pitch, the runners are entitled to advance one base.
73	37	T	8.	The batter steps back to swing at a pitched ball, and as the bat moves toward the ball it strikes the catcher's mask. The umpire gave the batter one base.
90	23	T	9.	Home plate, first, and third are entirely within the playing diamond.
87	9	T	10.	The catcher's receiving position is as close to the batter as possible without danger of tipping the bat.
90	0	F	11.	A good batter, in a ready position, is one who stands up to the plate with the bat resting on his shoulder with his weight on his rear foot.
47	27	T	12.	A ball is called on the batter if the pitcher takes a pitching position near the pitcher's rubber without having the ball in his possession.
77	34	T	13.	A left-handed hitter has the advantage over a right-handed hitter in performing the drag bunt in that he doesn't have quite as far to run.
74	47	T	14.	The right fielder catches a foul fly. The runner on third base is permitted to tag up after the catch and score on the play.
84	32	T	15.	In delivering the ball to the batsman, the pitcher's wrist must not be farther from the body than the elbow.
94	15	T	16.	According to the official softball rules, the visiting team bats first.
59	63	F	17.	A bunted pop fly comes under the infield fly rule and the batter is automatically out.
84	16	T	18.	Both feet must be in contact with the pitcher's plate when the pitch is started.
92	40	F	19.	According to the official rules, a regulation game consists of nine innings.
74	72	T	20.	Base runners may legally advance at their own risk after a foul fly has been caught for a put out.
90	23	F	21.	Ten men constitute a team.
34	6	T	22.	Players can change positions in the field as well as change their batting positions; the only thing is that they cannot bat any sooner than they did in the original line-up.

Difficulty Rating	Index of Discrimination	Answer	No.	Statement
20	24	F	23.	Most ground balls are missed because the ball goes above the fielder's glove.
81	38	T	24.	It would be possible for a pitcher to strike out 21 men in a seven-inning game and still get beat 2-0.
32	36	F	25.	An infield fly rule can occur with second base unoccupied.
30	29	F	26.	On an attempted sacrifice bunt, the base runner waits until the ball is on the ground before starting toward the next base.
87	55	T	27.	On a legal pitch, the umpire usually considers the pitcher's wind-up started when he takes one hand off the ball.
87	63	F	28.	The umpire behind the plate signifies "strike one" by projecting the forefinger on his left hand.
95	43	F	29.	There is no defense against a double steal in softball.
90	38	T	30.	The batsman can change from one side of the plate to the other during the same time at bat providing the pitcher is not in position to start his throw.
80	39	F	31.	A batted ball which hits the outside corner of first base without being touched and then comes to rest in foul territory is ruled a foul ball.
78	—28	F	32.	The batsman is struck by a pitched ball. As the batsman is going to first base, a runner on second may advance to third base.
80	32	T	33.	The runner is out if he is tagged with the ball while off base after a foul tip has been caught by the catcher.
88	48	F	34.	A good soft ball pitcher with plenty of control always throws the ball as hard as possible to the batter.
82	11	F	35.	The fungo bat is used frequently by the batter in the game of softball.
82	32	F	36.	A good outfielder "back-pedals" as fast as possible when a ball is hit high over his head.
92	30	T	37.	The pitcher is not in pitching position until the catcher is in position to receive the pitch.
43	42	T	38.	A base runner may steal a base if the batter tips the ball and the catcher catches it.
81	16	T	39.	For every unfairly delivered pitch the umpire shall call one ball.
51	25	F	40.	The score always reverts to the last completed inning when a game is terminated before the regulation seven innings have been played.
39	25	F	41.	The first and third base coaching boxes are adjacent to the first and third base lines.

Difficulty Rating	Index of Discrimination	Answer	No.	Statement
57	42	F	42.	The ideal situation for a "do or die" squeeze play is with a good hitter at bat and a fast man on third and two outs.
90	17	F	43.	The base runner on first is out if a batter hits an infield fly.
65	39	T	44.	For all team plays there must be signals and the more simple the signals the less chance that they will be missed.
97	23	F	45.	A sacrifice bunt should not be used in a game when the game is close.
84	13	T	46.	The squeeze play is a variation of the sacrifice bunt.
68	44	F	47.	On extra base hits to right field, the short stop should go out toward the outfielder fielding the ball.
98	30	F	48.	Base running is an important part of offensive softball, but there is little value in placing a first and third base coach in their respective coaching boxes as the base runner never uses them.
69	42	T	49.	With no runners on base, the short stop should play as deep as his throwing arm will allow and come in on balls hit to him.
95	30	F	50.	The game of softball as we know it today is derived from the old game of handball.
35	2	T	51.	A base runner should be given ample time to return to the base he occupied when the ball was fouled. But in the case where the pitcher delivers a pitch to the batter before the base runner returns to his base, the base runner may advance to the next base at his own risk without returning to that base.
69	21	F	52.	A batter, while standing in the batter's box, swings at a pitched ball which strikes his bat and then strikes the batter and lands inside the playing field. The ball is in play and the batter can be put out.
91	17	T	53.	When a game is in session and there are two umpires working the game, either one of them may suspend play when in his judgment conditions justify such action.
100	0	F	54.	Since softball is such a mild activity, there is very little need to warm up before practice or a game.
80	21	F	55.	A base runner going from second and hit by a line drive is allowed to advance to third base.
71	— 2	T	56.	If an umpire finds that he has miscalled a play, it is not only his right, but his duty to call the play correctly.

Difficulty Rating	Index of Discrimination	Answer	No.	Statement
29	—12	F	57.	When the ball is in play and the base runner is caught off base, the only way he can be put out is to be tagged with the ball.
53	30	F	58.	Outfielders always warm up before a game with a skill drill called "pepper."
64	32	T	59.	When an umpire makes a decision concerning a play and then realizes that he made a mistake, it is his duty and responsibility to reverse his own decision and call it right.
66	68	F	60.	If three men are on base, the batter steps across the base and hits a home run, four runs are scored.

Part No. 2:

Fill in blanks by placing the right answer in the corresponding blank on answer sheet. (Fill in all blanks—one off for each blank.)

Difficulty Rating[1]	Index of Discrimination[2]	Answer	No.	Statement
			1–2.	A forfeited game shall be declared by the _____ in favor of the team not at fault and the score shall be recorded as _____ to 0.
97	23	Umpire		
88	61	7		
			3.	In setting up the distance of the pitcher's rubber from home plate, the _____ line of the pitcher's plate shall be 46 feet from the back corner of the home plate.
58	34	Front		
			4–6.	In the act of delivering the ball to the batsman, the pitcher shall not take more than _____ step (or steps) which must be _____ and _____ the batsman.
90	29	1		
48	15	Forward		
57	23	Towards		
			7.	An illegal pitch entitles the batter to advance _____ base, or bases.
32	29	0		
			8–9.	When a pitcher delivers three strikes to a batter and on the last strike the catcher drops the ball and the batsman makes it to first—on the score sheet the pitcher is credited with one _____ and the catcher one _____.
77	52	Strike-out		
90	— 4	Error		
51	21	Fair	10–11.	The batsman is out if he bunts _____ and strikes the _____ again as he is going to first.
94	21	Ball		
			12.	If there are two outs, men on first and third and the catcher drops the third strike, the batter automatically becomes _____.
38	43	Baserunner		
			13–14.	If a fielder stops or catches a batted ball with his cap, glove, or any part of his uniform, while detached from its proper place on his person, the runner or runners shall be entitled to _____ bases and _____ bases if it's a thrown ball.
43	42	3		
54	33	2		

[1]The lower the rating, the more difficult the question.
[2]The higher the index, the more discriminatory the question.

Difficulty Rating	Index of Discrimination	Answer	No.	Statement
36	29	Safe	15.	The two types of squeeze plays are the suicide squeeze and the _____ squeeze.
69	73	2nd Baseman	16.	With a runner on first and right-handed hitter up to bat, it is the responsibility of the _____ to cover second base if the runner on first attempts to steal.
59	50	0 or 1	17–18.	Explain situation in which the infield fly rule would cause the batter to be automatically out. Number of outs _____? Bases occupied _____?
40	49	1, 2 or 1, 2, 3	19.	For better control in throwing a softball, the ball is gripped between the thumb and first _____ fingers.
47	29	3	20.	The squeeze play is used only when a runner is on _____ base.
89	51	3rd	21–22.	A _____ arm caused by throwing the ball should be _____ slowly, especially in cold weather.
85	25	Sore	23.	When catching a fly, an attempt should be made to catch the ball _____ the shoulders.
80	0	Warmed	24–25.	A left-handed hitter always places his _____ hand above the _____ hand when he assumes a correct ready position at the home plate.
58	29	Above		
93	40	Left		
95	40	Right		

Part No. 3: (Directions) *Fair or Foul Ball*—If statement makes the ball *fair*, write *fair* on answer sheet. If statement makes the ball *foul*, write *foul* on answer sheet. (*Do not guess.* Scoring R—W.)

Difficulty Rating[1]	Index of Discrimination[2]	Answer	No.	Statement
82	44	Fair	1.	A legally batted ball lands foul; rolls fair between home plate and first base and is picked up by a fielder in fair territory.
49	61	Fair	2.	A legally batted ball lands foul, rolls fair as it passes first base and then comes to rest in foul territory.
61	52	Fair	3.	A legally batted ball on a line drive hits the outside corner of first base and comes to rest on the players' bench.
72	37	Foul	4.	A line drive passes over third base in fair territory and then curves and lands in foul territory.
95	30	Fair	5.	A line drive passes over third base in fair territory, hitting the third baseman, and lands in foul territory.

[1]The lower the rating, the more difficult the question.
[2]The higher the index, the more discriminatory the question.

Part No. 4 Place a (+) sign in the blank on the answer sheet if the ball is in play and the runners can advance at their own risk. If the ball is dead (not in play), place a (—) sign on the answer sheet. (*Do not guess.* Scoring R—W.)

Difficulty Rating[1]	Index of Discrimination[2]	Answer	No.	The Ball is in play or dead:
60	49	+	1.	After "four balls" have been called provided the batsman cannot be put out before he reaches first base.
82	38	—	2.	In case of a batsman stepping from one box to the other when the pitcher is in the act of pitching.
80	69	+	3.	In case of a foul-hit fly legally caught.
66	41	+	4.	In case of a foul tip caught by the catcher.
43	27	+	5.	In case of a thrown or pitched ball striking an umpire.
64	58	—	6.	In case a fair-hit ball strikes a base runner before passing a fielder.
82	11	—	7.	If a batter unintentionally strikes the ball a second time on the same pitch.
66	23	+	8.	After an interference by a fielder with a base runner, provided that the runner interfered with cannot be put out before he reaches the base to which he is going.
70	52	+	9.	After a foul tip has been legally caught.
75	21	—	10.	In case a pitched ball is rolled along the ground by the pitcher.

[1]The lower the rating, the more difficult the question.
[2]The higher the index, the more discriminatory the question.

(Submitted 7/19/54)

Notes & Comments

Teaching Load of Women in Physical Education in Colleges and Universities

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SINCE THE SUBJECT of teaching load is so frequently discussed at conferences of professionals in physical education, this study was undertaken at the suggestion of the Midwest Association of College Teachers of Physical Education for Women. It was conducted by means of two questionnaires sent to heads of departments and staff members in the Midwest District and to some in the Central District.

The first questionnaire, in 1947, was very general, inquiring about ratios of students to staff in different types of institutions, average numbers of teaching hours of faculty members in physical education and their comparison with teaching loads of staff members of other college and university departments, some indication of relative values of different types of assignments which are a part of the total load in physical education and a statement of what physical educators considered a "fair" working load.

Results of the first study gave the following data: Ratio of staff to students in departments with professional courses was 1:107 and in those without professional courses, 1:196. The average number of hours taught by physical educators was: Chairmen—21.7; Staff Members—23.9. The average number of hours taught in other departments was: Chairmen—13.4; Staff Members—15.5. "Fair" teaching loads were: Chairmen—16.5; Staff Members—19.8. Estimates of fractional values of other teaching assignments as compared with a lecture hour:

	Range
Laboratory	1/2 to 2/3
Extracurricular	1/4 to 2/3
Observation of student teachers	1/8 to 4/9

Since the results of the first questionnaire indicated such a difference of opinion about this important and difficult problem, a second study was undertaken on the basis of that by Krakower[1]—a study on teaching hours of men in education. From a review of the literature in physical education, the Krakower Report seemed to be the only one done in enough detail to contribute material for future studies on the college and university level.

Summary of Functional Weightings

In making a survey of teaching load in which some evaluation of the various types of assignments falling within the job of the teacher of physical education would appear, questionnaires were sent to members of the Midwest Association of College Teachers of Physical Education for Women and to some members of the Central District. Out of the 189 questionnaires sent, 66 were returned in time to be tabulated and with answers sufficiently complete to be used. The basis of the weighting was a lecture hour to which a weight of three was assigned on the theory that each lecture hour would require two hours of outside preparation. Thus a 15- or 16-hour schedule of lectures would yield a work week of 45 or 48 hours.

[1]Krakower, Hyman, National Survey of Teacher Loads in Departments of Physical Education in Institutions of Higher Education, *Research Quarterly*, Dec. 1945, pp. 288-292.

In Table 1, the first column presents the average of the weightings assigned by participants in this study; numbers in parentheses are numbers of replies; the second column shows similar figures from the Krakower study on college men.

TABLE 1

Summary of Functional Weightings To Be Given to Teaching and Other Assignments in Physical Education

Assignment	Weight	Krakower Study
1a. Lecture period	3.00 (52)[1]	
b. Repeat lecture period	2.02 (48)	2.2 (37)
2a. Combined lecture and laboratory period	2.47 (50)	
b. Repeat lecture and laboratory period	1.77 (45)	
3a. Laboratory periods	1.76 (53)	2.1 (36)
b. Repeat laboratory periods	1.43 (45)	
4a. Regular extra-curricular activities	1.70 (53)	2.1 (28)
b. Repeat extra-curricular activities	1.44 (50)	
5. Extra-curricular (no instruction)	1.20 (51)	
6. Observation student teachers	1.62 (41)	
7a. Health conferences	1.40 (37)	
b. Student teacher conferences	1.70 (43)	1.2 (28)
c. Managers	1.43 (49)	
8. Research	2.02 (30)	1.8 (25)
9. Others	1.95 (21)	
Major conferences	Sports days	
Freshmen conferences	Camp Placement Bureau	
Faculty advisers	NSGWS	
Staff meetings	Administration	
Student organizations	Parties	
Water Safety Instructors	Clinic	

[1]Figures in parentheses are the numbers of replies.

Table 2 shows weighted teaching loads in various combinations. Weightings are those of Table 1 secured from this study.

TABLE 2

Present Weighted Teaching Load

	Combination of Lecture, Lecture and Lab., Lab.	Combination of Column One and Student Teachers	Total Work Load
Institutions over 1000	29.64	35.65	53.76 (37)[1]
Institutions under 1000	32.38	35.31	46.82 (29)
Total of all institutions	30.84	35.50	50.71 (66)
Chairmen	32.80	34.22	52.83 (18)
Professors	30.39	39.63	54.23 (24)
Instructors	30.20	32.62	45.60 (24)

[1]Figures in parentheses are the numbers of replies.

Conclusions

Laboratory periods in physical education are given a weighting in this study of 1.76; in the Krakower study, 2.1. Regularly scheduled extra-curricular activities carry about the same weightings as laboratory courses in each study. In the Krakower study, however, they carry a slightly higher rating than in the present study. The Krakower study gives less importance to student conferences and research than does the present study.

When the weightings suggested in the present study were applied to the various assignments in teaching loads, the highest work load reported was for professors, 54.23 hours per week; chairmen of departments ranked next with a weighted work load of 52.83; and instructors lowest with 45.60.

It is hoped that these results will contribute in some way to a practical solution of the problem of the evaluation of teaching load.

Studies Reported by the Clearinghouse for Research in Child Life, 1948-51

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PERHAPS THE GREATEST responsibility of the educational system in the days ahead will be research activity and this type of study should offer, to some degree, possible solutions to the systematic and continuing exercise of the most imaginative intelligence of our people. Though the evidence seems to be convincing that the schools of today are doing an excellent job of teaching, it would seem that additional emphasis on continuous and comprehensive research cannot be slighted.

Recognizing the importance of research, this study was designed to illustrate the frequency of reported research studies relating to children as indicated from 1948 through 1951. These data were extracted from the *Clearinghouse for Research in Child Life.*[1]

According to Table 1, cumulatively, from 1948 through 1951, we find the listing of research investigations ranked as follows: (1) Physical Health and Disease, 957; (2) Behavior and Personality, 797; (3) Social, Economic, and Cultural Factors, 636; (4) Educational Process, 341; (5) Growth and Development, 309, and (6) Pregnancy and the Prenatal Periods, 264.

TABLE 1

Frequency of Reported Research as Related to Children

Type of Investigation	Comparative Inventory of Studies			
	1948-49	1949-50	1950-51	Total
A. Behavior and Personality	372	62	363	797
B. Educational Process	159	18	164	341
C. Growth and Development	166	30	113	309
D. Physical Health and Disease	524	91	342	957
E. Pregnancy and the Prenatal Period	135	34	95	264
F. Social, Economic and Cultural Factors	246	70	320	636
Sum totals	1602	305	1397	3304

It is interesting to note that of the 3,304 research studies relating to children reported in the *Clearinghouse* volumes studied in the report, approximately 29 percent are concerned with physical health and disease; slightly less than 25 percent reflect an interest in behavior and personality; some 19 per cent relate to social, economic and cultural factors; 10 percent refer to the educational process; 9 percent bear upon growth and development; and 8 percent pertain to pregnancy and the prenatal period.

[1]*The Clearinghouse for Research in Child Life*, Children's Bureau, U. S. Department of Health, Education, and Welfare, Washington 25, D. C., 1948-51.

Warm-up and Fatigue in Junior High School Sprints

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DURING 12 YEARS of track competition, the writer has heard only one criticism of the presently accepted philosophy that an adequate warm-up is needed before an "all out" effort can be achieved.[1] However, as a physical education teacher in a junior high school,

[1]Dr. Maxwell Howell, a former Australian rugby star, has stated to the writer that athletes and coaches in that country laugh at the American system of tiring the athlete by warming up before a race. The Australian method is to use massage.

he has often watched the boys run "all out" with absolutely no warm-up, and has observed only a single case of pulled muscle.

To secure some practical information on pre-race warm-up, and at the same time learn something about how rapidly eighth grade boys (age 12 and 13) become fatigued in short sprints, a series of test runs were made. These boys were unsophisticated, with no preconceived ideas concerning the need of warm-up. To disguise the purpose of the experiment, all of the boys in the lower eighth class were called together and informed that there would be a contest between squads. Each squad was to select its five best runners. Each runner was to run the 50-yd. dash five times. The scoring was to be done by adding the times of all five races for each of the five boys on each squad. The importance of running all five races as fast as possible was emphasized. Two squads, or ten boys, were to run each day till all had run.

Pre-race warm-up was kept at a minimum. The boys had been in academic classes for the first 1½ hours of school. They came to the gym, dressed, and then walked to the track. Here they were matched in pairs according to previously observed speed, so that there would be consistent competition during the races. As soon as five pairs had run, the procedure was repeated until each pair had done the five races. This meant that each boy ran 50 yards on five occasions, with a rest of approximately five minutes after each run.

Table 1 shows that 90 per cent of the fastest runs were distributed equally among the first three trials, when each one of a boy's runs was ranked from No. 1 to No. 5 in speed. His runs ranking No. 2 and No. 3 were distributed almost equally among the first four trials, while rank No. 4 was usually the fourth trial and No. 5 occurred most often on the fifth trial. The average speed was the same for the first three trials, became 2 per cent slower for the fourth, and had slowed 3.7 per cent by the last trial.

TABLE 1

Time Scores and Inter-relations in Successive 50-Yard Runs

N = 28	I	II	III	IV	V
M (Sec)	7.12	7.11	7.11	7.25	7.37
σ	0.46	0.42	0.43	0.44	0.53
t	.....	0.42	0.00	4.92	2.57
r	.....	0.89	0.87	0.94	0.91
Best runs	30%	30%	30%	3%	7%

Since three 50-yd. runs during ten minutes was all the exercise these boys could accommodate without the first appearance of fatigue, it seems likely that the amount of exercise used was enough to cause warm-up if it is practical to use warm-up in eighth grade boys. The first race had no beneficial warm-up effect on the second race, and cumulative warm-up of the first and second races had no beneficial effect on the third race. The fourth and fifth races were a little slower because of fatigue. The possibility that pre-race stretching exercises might be beneficial was not tested. The results agree with observations at Springfield College.[2]

Individual scores indicate that the amount of fatigue from running 5 dashes within 20 minutes was not excessive. Six boys slowed down a half-second between the third and fifth trials. This is only 7 per cent decrement. Between the fourth and fifth, only one boy slowed this much and only 7 boys dropped off as much as .3 or .4 sec. (4% to 5%).

With more sophisticated athletes who were convinced of the need for warm-up, some method of psychological control would have been required. Since the results were negative, the factor of suggestion does not have to be considered as a possible explanation in this experiment.

[2]P. Karpovich, *Physiology of Muscular Activity*, Philadelphia: W. B. Saunders Co., 1953, p. 14.

Research Abstracts

Prepared by the Research Abstracts Committee of the National Council of the Research Section, PAUL A. HUNSICKER, Chairman

Anatomy

24. ACHESON, ROY M., and D. HEWITT. Physical development in the English and the American pre-school child. *Human Biology*, **26**: 4: 343-355 (Dec. 1954).

The physical development of approximately 500 Oxford children from different economic levels, followed in the first 5 years of life, was compared with that of the Brush Foundation children. On the average, the English children were shorter and less skeletally mature (Todd). To avoid systematic error in techniques, only increments were studied. The English increments as percentages of the American were estimated as: (1) Stature increase per unit of time: boys, 96 per cent; girls, 95 per cent. (2) Skeletal maturity increase per unit of time: boys, 90 per cent; girls, 101 per cent. (3) Stature increase per unit of skeletal maturity increase: boys, 96 per cent; girls, 86 per cent. These findings parallel those found between the different economic strata within the Oxford Survey.—*D. B. Van Dalen.*

Education

25. BANNING, EVELYN I. Teacher attitudes toward curriculum change: the effect of personal relationships on the degree of favorableness. *J. of Exp. Educ.*, **23**: 2: 133-146 (Dec. 1954).

Sixty-five junior high school classroom teachers in a New England community of 50,000 population participated in the study. The factors in the teaching situation that related in a positive way to attitudes toward curriculum change reveal that teachers are more favorable if they feel they are making a contribution to the school organization as a whole and they have a meaningful share in policy decisions and their implementations; if their relationships with pupils in the classroom is a harmonious one; and if they are active participants in the life of the community. The findings indicate that these four factors affect the attitudes of teachers more than the factors of teaching-load, subject or grade taught, or any of the mechanical conditions of work.—*D. B. Van Dalen.*

26. CURRAN, FRANK J. Specialized techniques in the treatment of juvenile delinquency. *J. Am. Med. Assn.*, **157**: 108-113 (Jan. 8, 1955).

Early procedures in treating the delinquent child are referred to as "environmental manipulation." The first Child Guidance Clinic which utilized the teamwork approach was established in Chicago in 1909 by Dr. William Healy. In 1937 a special ward for treating the adolescent delinquent male was founded at Bellevue Hospital in New York City. A follow-up study of 1,626 cases showed that 35-88.2% of the cases continue to be delinquent.

Detention homes care for children who are facing court action and who are not in the custody of their parents. Long-term residence treatment, such as that at Freeville, New York's Junior Republic, strives for "mature creative living in a democratic society." Reformatories promote philosophy of firm discipline. The Chicago Area Project aims to discover predelinquents and provide programs of recreational activities.

Co-ordination and utilization of all community resources, both professional and lay groups, is essential in dealing with the problem. A teamwork approach is highly important for the delinquent and his family. Physicians should work especially to establish special wards for adolescent treatment.—*Elena M. Sliepcevich and Peter Karpovich.*

27. KAPLAN, JEROME. Observations on the somatic and psychosomatic significance of group activity on older people, *Mental Hygiene*, **38**: 640-646 (Oct. 1954).

The author discusses the value of group activity for assisting older people to maintain feelings of usefulness, status, and belonging. He cites the experience of these groups, Golden Age clubs, and the like throughout the country which have enabled older citizens to remain a contributing member to society, have restored some degree of capacity and a full degree of social capabilities, and have had a direct bearing on reducing medical and psychiatric expenditures. Experimental work indicates that even the aged mentally ill may benefit from these group techniques.—*Bruce L. Bennett.*

28. SCHULTZ, DOUGLAS G., and HENRY N. RICCIUTI. Level of aspiration measures and college achievement, *J. of Genl. Psychology*, **51**: 267-275 (Oct. 1954) .

Goal discrepancy scores were obtained for 53 college men by using aspiration statements with two group experimental tests and with regular course examinations. The discrepancy scores were correlated with a scholastic aptitude test and with the grade-point average made during the previous year in college. The findings showed that there was little, if any, correlation between goal discrepancy scores and previous college achievement.—*Bruce L. Bennett.*

29. SINGER, ARTHUR. Social competence and success in teaching. *J. of Exp. Educ.*, **23**: 2: 99-132 (Dec. 1954).

Forty-one in-service teachers in 18 Wisconsin senior high schools participated in the Study. The most successful teachers were more popular and held in greater esteem as friends by their colleagues and students than the least successful teachers. Little or no relationship was found between the teacher's social adjustment and teaching success, with one exception. Insignificant correlations were found between teacher-student social distance scales. Moderately high coefficients of correlation were found in almost all cases between social competence and composite measures of teaching success. Moderately high correlations (.352 to .581) were found to exist between the staff's rating of the individual teacher for social acceptability and measures of teaching success. Significant correlations were found between student-teacher social distance scale ratings and teaching success measures. Definite mean differences existed between the 14 most successful and the 14 least successful teachers in 24 of the 28 measures of social competence. Length of teaching service was not a significant factor in the relationship between teacher efficiency and social acceptance.—*D. B. Van Dalen.*

30. WADE, DURLYN E. Social class in a teachers college, *J. of Educ. Sociology*, **28**: 131-8 (Nov. 1954).

The purpose of this study was to determine whether academic grades received by students in a teachers college and participation in extra-curricular activities were biased according to social class status.

A total of 419 student teachers at an unidentified teachers college were classified as to social status by the Warner Index of Status Characteristics. A comparison was then made between social class distribution and distribution of certain rewards received by students, such as academic grades, social acceptance scores from fellow students, participation in extra-curricular activities, and recognition by faculty and administration.

The results indicated that students in the upper social classes generally received a greater proportion of rewards than those in lower social classes. There were a few exceptions where no significant differences were found, such as social acceptance scores men received from men and rewards governed by college policies.

It is unfortunate that the investigator did not include varsity and intramural sports as extra-curricular activities. Furthermore, even though upper social class students do receive a greater proportion of the higher grades, it does not necessarily follow that this is undesirable as long as the grades are justly earned. Perhaps lower social class students have part-time employment which takes time from their studies and thus affects their grades adversely.—*Bruce L. Bennett.*

Health

31. Bradley, Charles. Pediatrics, mental retardation, and delinquency. *J. Am. Med. Assn.*, **157**: 101-108 (Jan. 8, 1955).

The incidence of mental retardation is no greater in groups of delinquents than it is in the general population. However, certain hazards exist for the retarded, such as their limited ability to comprehend social standards, gullibility, and difficulty in maintaining family and peer standards.

There are 4,500,000 mentally retarded in the United States, of which one-third are children. The degree to which the child is retarded in comparison to others of his age group is more important than the cause or type of deficiency.

The problem for physicians is how to deal with parents. Medical therapy is useful in only a very small number of cases. A positive, constructive approach and adequate long-range plans for the retarded should largely provide assurance that they will not become delinquent.—*Elena M. Sliepčevich and Peter Karpovich.*

32. D'Esopo, Nicholas D. Drugs that fight tuberculosis. *Today's Health*, **32**: 34-35, 58-60 (Nov. 1954).

The discovery of streptomycin in 1944 was of momentous importance as a drug used against the tubercle bacillus and yet well tolerated by man. The drug was found to be extremely potent: one part in a million was enough to stop the multiplication of tubercle bacilli. However, there was one important drawback in the use of streptomycin: the tubercle bacilli rapidly became resistant to it. In 1948 a second drug was introduced—para-aminosalicylic acid (PAS) which is relatively ineffective against the tubercle bacillus when used alone but has the remarkable property of preventing the tubercle bacillus from becoming resistant to streptomycin when the two drugs are prescribed together. In 1952, a third member of the present chemo-therapeutic family was discovered—isoniazid. This drug, however, has the same drawback as streptomycin: tubercle bacilli readily become resistant to it. The combination of this drug with streptomycin or PAS has worked out quite well. None of these combinations kills tubercle bacilli; but they effectively prevent their multiplication. The final victory in the fight against tuberculosis rests not only in drug administration but in the discovery of new cases.—*J. Grove Wolf.*

33. Eichenlaub, John C. How to avoid ulcers. *Today's Health*, **32**: 16-17, 52 (Oct. 1954).

An ulcer is a hole in the protective lining of the stomach or upper intestines through which the acid and digestive juice made in the stomach wall eat at the underlying tissue. To avoid and eliminate ulcers it is recommended that you dodge the feelings which let an ulcer get started by steering clear of situations which might call them forth. Secondly, you can change some of your attitudes and, thirdly, you can find outlets or antidotes for the feelings that set an ulcer off—resentment, frustration, hurt, and inadequacy. Stomachs should be soothed, not abused, in times of stress.—*J. Grove Wolf.*

34. Hardy, Martha C. Outcomes of a hearing and vision conservation program demonstration in a metropolitan school system, *J. of School Health*, **25**: 6-12 (Jan. 1955).

The purpose of this paper is to report some tangible results from an appraisal of a comprehensive hearing and vision conservation program. The results represent the findings on nearly 75,000 pupils tested in hearing and vision between 1949-51 in a large metropolitan area. The combined efforts of voluntary health agencies, private physicians, and schools were employed in making the survey. Approximately 3% of the children had hearing impairments and over 15% had vision difficulties.—*Joseph E. Lantagne.*

35. National Dairy Council. Homogenized vitamin D milk and human health. *Dairy Council Digests*, **26**: 1-4 (Jan. 1955).

Pasteurization and homogenization can only be considered as beneficial to human health, increasing the sanitary quality and palatability of milk under modern distribution

methods and not adversely affecting its nutritive value. Vitamin D fortification of milk is a public health measure which has aided in eliminating rickets in the United States. Most vitamin D milk is fortified by the direct addition of the vitamin in the form of a sterile canned concentrate dissolved in a milk carrier.—*Paul Hunsicker.*

36. THRIFT, P. E., and R. B. WARD. Dietary patterns of Negroes in the community of Scotlandville, Louisiana. *J. of Exp. Educ.*, **23**: 2: 149-155 (Dec. 1954).

The characteristic meal pattern was a heavy breakfast, light lunch, and a heavy dinner. Food dislikes caused the exclusion of many essential foods from the family diet. The average amount spent for food per year increased with income. The percentage spent for food ranged from 86% for families with an income up to $500 per year to 21% for families with an income in excess of $5,000 per year.—*D. B. Van Dalen.*

37. THRIFT, P. E., and R. B. WARD. A study of the relationship between the diets and the health of 25 Negro families in Scotlandville, Louisiana. *J. of Exp. Educ.*, **23**: 2: 157-159 (Dec. 1954).

Sixty-eight per cent of families were consuming less calories than recommended. Twenty, 60, 40, and 20% of the families were not receiving adequate amounts of protein, calcium, phosphorus, and iron, respectively. Twenty-five to 44% of the families were receiving less than the recommended amounts of vitamins. The physical examination revealed that 20% were underweight, 52% were overweight, and 52% had dental caries. Ninety per cent of the subjects had ailments of dietary origin.—*D. B. Van Dalen.*

38. WALKER, PAULINE F. Implementing mental health in the senior high school, *Mental Hygiene*, **38**: 565-69 (Oct. 1954).

The author describes her experience in teaching a senior high school class which studies the role of psychology in the science of mental health. The goal of the class is to increase the happiness and efficiency of its individual members. The writer expresses the need for more mental health education for all teachers and the need for psychiatrists and psychologists to come out of the clinic and assist teachers in a broad educational program which would improve the mental health of students.—*Bruce L. Bennett.*

39. WILSON, CHARLES C., and ERIC WOOD. A survey of school lunch practices, *Am. J. of Pub. Health*, **45**: 163-167 (Feb. 1955).

According to the authors, about 56,000 public schools participated in the national school lunch program in 1954 and 1.7 billion meals were served. Because of the importance of the school lunch to the welfare of school children, an analysis of health practices of both the employees and students seemed advisable. A sampling of these practices indicated clearly that there is a need for periodic sanitary inspections and a need for continued health instruction.—*Joseph E. Lantagne.*

Physiology

40. BANNISTER, R. G., and D. J. C. CUNNINGHAM. The effects on the respiration and performance during exercise of adding oxygen to the inspired air. *J. Physiology* **125**: 118-137 (July 1954).

Observations on two athletes and two non-athletes during work on a treadmill showed that breathing 33%, 66%, and 100% O_2 decreased pulmonary ventilation and blood lactate, and increased alveolar CO_2.

Breathing 66% oxygen resulted in favorable subjective responses in three of the subjects and they were able to continue work considerably longer than was possible when breathing either room air or 100% O_2. The authors contend that arterial anoxaemia is present during heavy exercise when breathing room air. It was suggested tentatively that the unfavorable results on performance and subjective symptoms arising from 100% oxygen were related to changes in the cerebral circulation.—*F. Henry.*

41. De Moor, Janice C. Individual differences in oxygen debt curves related to mechanical efficiency and sex. *J. Applied Physiology.* **6**: 460-466 (Feb. 1954).

A closed circuit method was used to obtain oxygen intake measurements during rest, exercise, and recovery periods on 22 men and 21 women (college students) who performed a submaximal exercise on an electric bicycle ergometer (680 kg m/min for 6 min. at 62 pedal r.p.m.). Analysis of the exponential 2-component oxygen recovery curves showed that men have a faster alactic velocity constant than women but do not differ in other factors. Less efficient men and less efficient women have larger lactate debt components, larger proportions of lactate debt in the total debt, higher zero-time intercepts for the lactate components, and slower lactate velocity constants than more efficient men and women. The differences were statistically significant.—*J. DeMoor.*

42. Solomon, Walter M. Progress in physical medicine and rehabilitation. *J. Am. Med. Assn.*, **156**: (8) : 753-755 (Oct. 23, 1954).

Many forms of therapy and physiological changes brought about by them have been studied in the past ten years. Therapeutic exercises have been evaluated clinically and in the laboratories and the information on the rate of blood flow, energy costs, flow of lymph, changes in muscular structure and strength are now available. Although massage has been used for centuries, its therapeutic value is now questioned. A great deal of information is still needed in all aspects of rehabilitation especially regarding methods of patient motivation. Recognition of the powers within the patient himself should be included in the total concept of rehabilitation. Tests are badly needed for appraisal of patient's potentialities.—*A. Allan Alexander and Peter V. Karpovich.*

43. Sontag, Lester W., and Stanley M. Garn. Growth, *Annual Review ow Physiology*, **16**: (1954).

The authors restricted their review to the field of human growth and further limited it, because of space requirements, to those aspects of human growth and development which have been given the most attention in the last few years. Recent advances in the field of defects, developmental in origin and stemming from insults early in the developmental sequence are reviewed. Information about one specific and unusual abnormality, retrolental fibroplasia, a postnatal defect is summarized.

Of particular interest to physical and health education is the review of the techniques for the description and evaluation of human growth. The authors concluded that while these findings do not invalidate the use of the grid either as a research tool or as an adjunct to appraisal, they indicate that the grid, like any attempt to fit individual growth data to massed data curves must be employed with certain reservations.—*Peter O. Sigerseth.*

44. Wells, P. V. Flarimeter tests on athletes. *American Heart Journal*, **48**:914-929 (Dec. 1954).

The flarimeter is a clinical instrument for testing circulatory fitness. Comparison of flarimeter tolerances were made between 104 Princeton crew members versus 1,303 first-class male insurance applicants. The outstanding characteristics of an athlete in these tests were a slow heart rate and large flarimeter tolerances. Fifty runners were compared with 105 athletes (included 11 crew, 12 basketball, and 32 swimmers) on a standard exercise (Master and Oppenheimer) test followed by a 30-sec. blow. Standard stimulus seemed to stabilize the circulation in athletes. Emotion plays an important part in college male athlete responses. Functional tests, like athletic performance, seem to be essentially tests of nerve co-ordination.—*J. Grove Wolf.*

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